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FIG. 2.—ANOTHER EXPERIMENT ON INERTIA.

PHYSICS WITHOUT APPARATUS.

A CURIOUS experiment is sometimes performed by itinerant physicists, and which may be described as follows: A broom handle is laid horizontally on two annular bands of paper. Then two boys are selected, and each having been provided with a razor, they are required to support the broom handle with these, the cutting edge of the razors being uppermost and in contact with the intervening paper. All being in readiness, the operator takes a stout stick, and, with all his strength, strikes the broom handle in the middle, when, much to the surprise of the spectators, the latter is broken into slivers, while the paper bands which supported it are not even cut by the razors. The experiment, which is based on the same principle, may be performed as follows: First, drive a needle into each end of a broom handle; then, having procured two goblets, place each one near the edge of a chair, and from one to the other suspend the broom handle horizontally by means of the needles. If, now, the broom handle be struck a sudden and powerful blow with a stout stick, it will be broken and the goblets will remain intact. The more powerful the blow the more successful will be the experiment. (Fig. 1.) The phenomenon is explained by the resistance of the inertia of the broom handle. The blow being given suddenly, the impulse has not the time to communicate itself from the molecules directly struck to the neighboring ones, and the first separate before the motion is able to be transmitted to the goblets, which serve as a support. The experiment represented in Fig. 2 is of the same nature. A wooden ball is suspended from the ceiling by a weak cord or thread, and a similar cord or thread is attached to the lower surface of the ball. If, now, a sudden jerk be given the lower cord, it will break, as shown in the figure, the motion communicated to it not having the time to diffuse itself through the spherical mass. If, however, on the contrary, the lower cord be pulled gradually and slowly, the upper one will give way, because, in this case, it supports the weight of the spherical mass. Examples of this kind might be multiplied *ad infinitum*. A lead ball shot from a gun against a window pane leaves in its passage through the glass a round hole, while if it be thrown by hand (and with less force, of course) it shatters the glass into fragments. It may be well to observe that liquids and gases when put in rapid motion are capable of exhibiting the same action. On blowing vigorously into a wineglass containing a hard-boiled egg, the latter may be made to jump out of the glass (Fig. 3), and, with a little skill and sufficient strength of lungs, it is possible to cause it to alight in another glass placed alongside of the first. Experiments of this sort, which might appear trivial to some, could be greatly extended; and we have been induced to continue our demonstrations of physical phenomena by the aid of common objects because of the interest they have excited with those who are engaged in primary teaching.

After mechanical physics we might touch on the subject of heat, and find a means of easily performing a large number of experiments on dilatation, conductivity, etc., without the aid of apparatus. If it be desired, for instance, to show the great conducting power of metals, it is only necessary to stretch a piece of fine muslin over a piece of polished metal in such a way that the contact is perfect. Then, if a live coal be placed on the muslin, it will be found that the latter does not burn, since the heat is entirely absorbed by the metal, which takes it up through the tissue and disseminates it through its mass. Fig. 4 shows a similar experiment. It consists in causing tin to melt on a playing card which is held over the flame of a spirit lamp. The metal is melted without burning the card.

Fig. 5 shows the arrangement for performing a remarkable and little-known experiment on the regelation of ice. A block of ice is supported on the edges of two iron chairs or other objects, and is surrounded with an iron wire, to which is attached a ten-pound weight. Little by little the wire penetrates the ice, and in about an hour will have passed entirely through it and fallen with the weight to the floor. What happens to the ice? One might suppose that it would be cut in two. But it is not; for it remains intact, and in a single piece, as it did at first. The reason of this is because, in measure as the wire penetrated the mass, the cleft that it made closed up again by regelation.

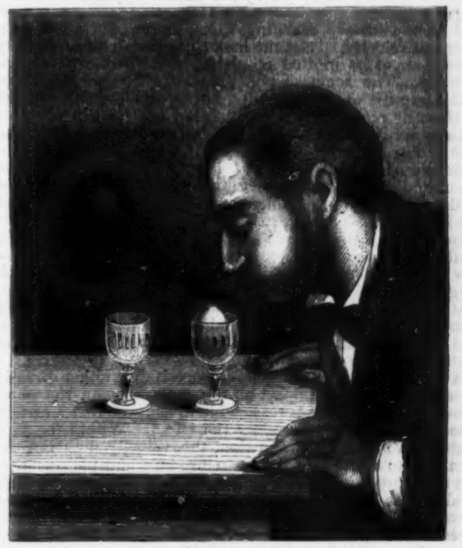


FIG. 3.—ACTION OF AIR PUT IN RAPID MOTION.

FIG. 1.—EXPERIMENT ON INERTIA.

ELECTRIC LIGHTS ON SPIRES.—A FAILURE IN ELECTRIC LIGHTING.

AN experiment in electric lighting has been lately made at Rouen, the negative result of which, though foreseen by competent men, has definitively proved that a solution of the problem of electric illumination cannot lie in use of a single center, or a group of centers, placed at a great height, as in a lighthouse. The occasion was that of the Rouen fêtes, on the 13th and 14th of June. Eight electric lights were placed on the spire of the cathedral, with a view to illuminating the town. Though the quantity of light was estimated at 5,000 Carcel burners, the effect was practically *nil*. The spire seemed merely to have a huge lamp on it, which threw its light beyond the town rather than in the neighborhood of the cathedral. The experiment was to have been tried again on the 14th of July, with sixteen electric lamps; but considering the very rapid decrease in the intensity of the electric light with the distance, the obliquity of the rays, etc., a successful advantageous result was not looked for.

WHEN bars of a magnetic nature are compressed, they have a tendency to resume their primitive molecular disposition when subjected to the action of a magnetizing current.

THE EARTH AS AN ELECTRICAL CONDUCTOR.

IN a paper on the earth as a conductor of electricity, Prof. Trowbridge, of Harvard, arrives at these conclusions: 1. Disturbances in telephonic circuits, usually attributed to effects of induction, are in general due to contiguous grounds of battery circuits. A return wire is the only way to obviate these disturbances. 2. The well-defined equipotential surfaces in the neighborhood of battery grounds show the theoretical possibility of telegraphing across large bodies of water without the employment of a cable, and lead us to extend greatly the practical limit set by Steinheil.

FIG. 4.—TIN MELTED ON A PLAYING CARD.

FIG. 5.—EXPERIMENT ON REGELATION OF ICE.

CONTRIBUTIONS TO MOLECULAR PHYSICS IN HIGH VACUA.*

THIS paper is a continuation of the Bakerian Lecture "On the Illumination of Lines of Molecular Pressure and the Trajectory of Molecules," read before the Royal Society, December 5, 1878. Phenomena there briefly referred to have since been more fully examined; new facts have been observed, and their theoretical bearings discussed; and numerous experiments suggested by Professor Stokes and others have been tried, with the result of acquiring much information which cannot fail to be of value in assisting to evolve a theory capable of embracing all the phenomena under discussion.

Experiments previously described have shown that the molecular stream hypothesis is the correct one. According to this, the molecules of the residual gas, coming in contact with the negative pole, acquire a negative charge, and immediately fly off by reason of the mutual repulsion exerted by similarly electrified bodies. Were the individual molecules solely acted on by the initial impulse from the negative pole, they would take a direction accurately normal to the surface repelling them, and would start with their full velocity. But the molecules, being all negatively electrified, exert mutual repulsion, and therefore diverge laterally. The negative pole, likewise, not only gives an initial impulse to the molecules, but it also continues to act on them by repulsion, the result being that molecules move with an accelerating velocity the further they get from the pole. The lateral divergence of the molecules, owing to their negative electricity, will naturally increase with the amount of charge they carry; the greater the number of collisions the more the molecules lose negative charge, and the less divergent the stream becomes. This hypothesis is borne out by facts. When the vacuum is just good enough to allow the shadow to be seen, it is very faint (owing to few molecular rays), but is quite sharp (owing to the divergence of the molecules laterally). The variation in mutual repulsion is shown by the fact that the focus projected from a concave pole falls beyond the center of curvature, and varies in position with the exhaustion, being longer at high than at low exhaustions.

Assuming that the phosphorescence is due, either directly or indirectly, to the impact of the molecules on the phosphorescent surface, it is reasonable to suppose that a certain velocity is required to produce the effect. Within the dark space, at a moderate exhaustion, the velocity does not accumulate to a sufficient extent to produce phosphorescence; but at higher exhaustions the mean free path is long enough to allow the molecules to get up speed sufficient to cause phosphorescence. At a very high exhaustion the phosphorescence takes place nearer the negative pole than at lower exhaustions; this I consider results from the initial velocity of the molecules being sufficient to produce phosphorescence, their greater speed being due to the fewer collisions near the negative pole.

The luminous boundary to the dark space round the negative pole is probably due to the impact of molecule against molecule, producing phosphorescence of the gas in the same way as the impact of molecules against German glass produces phosphorescence of the glass.

The following experiments were commenced at the suggestion of Professor Maxwell:

A tube was made as shown in Fig. 1. The terminal, *a*,

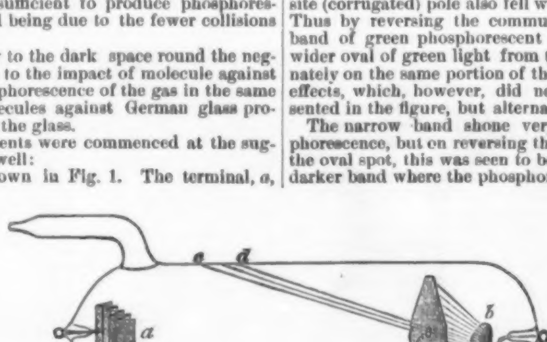


FIG. 1.

is a rectangular plate of aluminum, folded as shown in Fig. 2; the other terminal, *b*, is a flat disk of aluminum set obliquely to the axis of the tube. In front of the pole, *b*, is fixed a screen of mica, with a small hole in it, as shown at *c*; this hole is not in the axis of the tube, but a little to one side of it, so that rays starting normally from the center of the pole, *b*, may pass through it and strike the glass at *d*, while at the same time rays passing direct between the poles, *a* and *b*, can also pass through the hole.

The questions which this apparatus was to answer are: (1.) Will there be molecular projections from the negative pole, *a*, in two series of plane strata normal to the sides of the individual furrows, or will the projection be perpendicular to the electrode as a whole, *i. e.*, along the axis of the tube? and (2.) Will the molecular rays from the pole, *b*, when it is made negative, issue through the aperture of the screen, along the axis of the tube, *i. e.*, direct to the positive pole, or will they leave the pole normal to its surface and strike the glass as shown at *d*?

The tube was exhausted and connected with an induction coil; the following results were obtained: At a moderate exhaustion, the corrugated pole being made negative, the dark space entirely surrounds it, slight indentations being visible opposite each hollow, where there also is a lineal concentration of blue light. The appearance is in section as shown in Fig. 2. At higher exhaustions the luminous

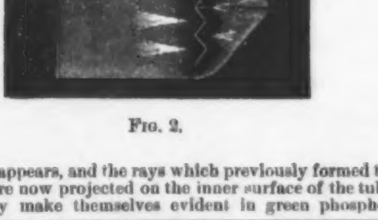


FIG. 2.

margin disappears, and the rays which previously formed the blue foci are now projected on the inner surface of the tube, where they make themselves evident in green phosphorescent light as portions of ellipses formed by the intersection of the several sheets of molecular rays with the cylindrical tube. Fig. 3 shows this appearance.

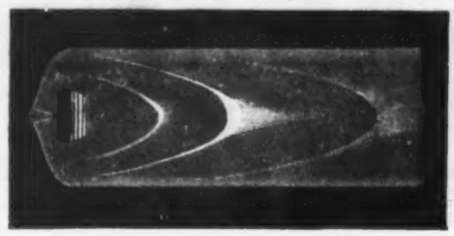


FIG. 3.

When the other pole was made negative, and the exhaustion was such that the dark space extended about eight millims. from the pole, the first appearance noticed was that of a ray of dark blue light issuing through the hole in the mica screen, and shooting upward toward the side of the tube, but not reaching it. Fig. 4 shows the dark space

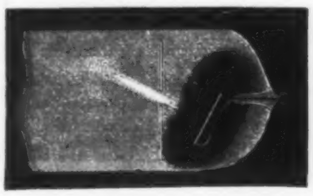


FIG. 4.

round the pole, and the ray of blue light. On increasing the exhaustion this blue line of light, and the luminous boundary to the dark space, disappeared, and presently a green oval spot appeared on the side of the tube, exactly on the place previously marked where the rays issuing normal from the surface of the pole should fall.

It happened that this oval spot fell on a portion of the tube where one of the elliptical projections from the opposite (corrugated) pole also fell when that was made negative. Thus by reversing the commutator I could get a narrow band of green phosphorescent light from one pole, or a wider oval of green light from the other pole, to fall alternately on the same portion of the glass. Fig. 5 shows these effects, which, however, did not occur together as represented in the figure, but alternately.

The narrow band shone very brightly with green phosphorescence, but on reversing the commutator and obtaining the oval spot, this was seen to be cut across the middle by a darker band where the phosphorescence was much less intense. The light of the band was always more intense than that from the spot; the impacts from the one being more concentrated than from the other, owing to the shape and position of the poles; moreover the experiments had been first tried with the corrugated pole negative. The glass along the band gradually becomes deadened by repeated impacts, and will not readily phosphoresce in reply to the weaker blows from the flat plate, although it still responds to the more energetic bombardment from the corrugated pole. This phenomenon almost disappears at very high exhaustions, or if the tube is allowed to rest for some time. The tired glass then recovers its phosphorescent power to some extent, but not completely.

To obtain this action in a more striking manner, a tube was made having a metal cross on a hinge opposite the negative pole. The sharp image of the cross was projected on

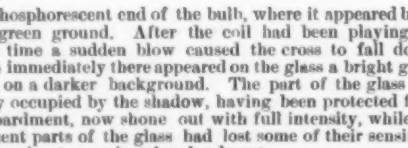


FIG. 5.

the phosphorescent end of the bulb, where it appeared black on a green ground. After the coil had been playing for some time a sudden blow caused the cross to fall down, when immediately there appeared on the glass a bright green cross on a darker background. The part of the glass formerly occupied by the shadow, having been protected from bombardment, now shone out with full intensity, while the adjacent parts of the glass had lost some of their sensitiveness, owing to previous bombardment.

This effect of deadening produced on glass by a long-continued phosphorescence was shown in a very striking manner at a lecture delivered at the Royal Institution on April 4, 1879, when the image of a cross was stenciled on the end of a large pear-shaped bulb.

I subsequently experimented further with this bulb, and found that the image of the cross remained firmly stenciled on the glass. The bulb was then opened and the wide end heated in the blowpipe flame till it was quite soft and melted out of shape. It was then blown out again into its original shape, and re-exhausted; on connecting it with the induction coil, the metal cross being down out of the line of discharge, the original ghost of the cross was seen to be still there, showing that the deadening of the phosphorescing powers of the glass produced by the first experiment at the Royal Institution had survived the melting-up and re-blowing out of the bulb.

When experimenting with this apparatus a shifting of the line of molecular discharge was noticed when the current was first turned on. The flat pole, *b* (Fig. 6), being nega-

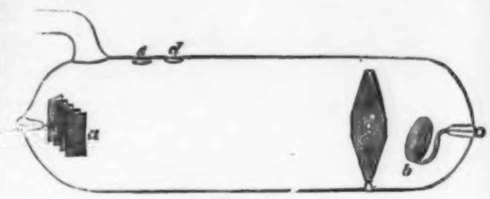


FIG. 6.

tive, and the line, *e d*, being normal to its surface, the spot of light falls accurately on *d*, when the exhaustion is sufficiently good to give a sharp oval image of the hole, *c*. But at higher exhaustions, when the outline of the image of *c* becomes irregular and continually changing, the patch of light at the moment of making contact is sometimes seen at *e*, and then almost instantly travels from *e* to *d*, where it remains as long as the current passes. The passage of the spot from *e* to *d* is very rapid, and requires close attention to observe it. If the coil is now stopped for a longer or shorter time, and contact is again made *the same way as before* (*b* being negative), the spot does not now start from position *e*, but falls on *d*, in the first instance. This can be repeated any number of times.

If now the pole, *b*, be made positive even for the shortest possible interval, and it then be made negative, the original phenomenon occurs, and the spot of light starts from *e* and rapidly travels to *d*. After this it again falls on *d*, *ab initio*, each time contact is made, so long as *b* is kept the negative pole. There seems no limit to the number of times these experiments can be repeated. The explanation of this result appears to depend on a temporary change in the condition of the wall of the glass tube when positively electrified molecules beat against it, a change which is undone by subsequent impact from negative molecules. This phenomenon is closely connected with some shadow and penumbra experiments described further on, and as the same explanation will apply to both I will defer any theoretical remarks for the present.

A suggestion was made by Professor Maxwell that I should introduce a third, idle, electrode in a tube between the positive and negative electrodes, so that the molecular stream might beat upon it, so as to see if the molecules gave up any electrical charge when impinging on an obstacle. A tube was therefore made as shown in Fig. 7; *a* and *b* are the

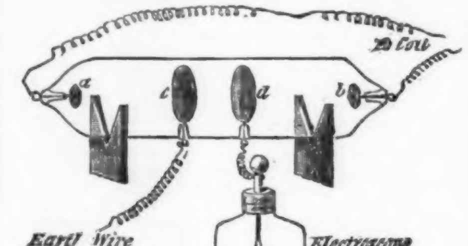


FIG. 7.

ordinary terminals; *c* and *d* are large aluminum disks nearly the diameter of the tube, connected with outer terminals. The poles, *a* and *b*, were connected with the induction coil, an earth wire was brought near the idle pole, *c*, and a gold leaf electroscope was brought near *d*.

On passing the current at inferior exhaustions, when the dark space is about 8 millims. from the negative pole, no movement of the gold leaves takes place whether *a* or *b* is negative, and whether *c* is connected with earth or is insulated.

At a good exhaustion, when the green phosphorescence of the glass is strong, the gold leaves are only slightly affected whichever way the current passes.

On increasing the exhaustion to a very high point, so that the green phosphorescence gets weaker and the spark has a difficulty in passing, the gold leaves are violently affected. When the pole, *a*, is negative, and *b*, positive, the leaves diverge to their fullest extent. On examining their potential it is found to be positive. The coil was stopped and the gold leaves remained open. A touch with the finger caused them to collapse. They then gradually opened again, but not to the original extent. The finger again discharged them, when they reopened slightly a third time. Experiment showed that the electrical excitement took many minutes to recover equilibrium. A Leyden jar put to the idle pole, *d*, was charged positively.

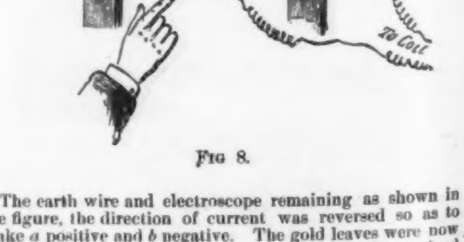


FIG. 8.

The earth wire and electroscope remaining as shown in the figure, the direction of current was reversed so as to make *a* positive and *b* negative. The gold leaves were now less strongly affected; they opened a little, and remained quivering, as if under the influence of rapidly-alternating currents.

* "Contributions to Molecular Physics in High Vacua. Magnetic Deflection of Molecular Trajectory; Laws of Magnetic Rotation in High and Low Vacua; Phosphorogenic Properties of Molecular Discharge." By William Crookes, F.R.S. (Extracts from a paper in the "Philosophical Transactions of the Royal Society," Part 2, 1879.)

The wires were rearranged as shown in Fig. 8, *b* and *d* being connected with the coil. When *d* was made negative, faint sparks about 1 millim. long could be drawn by the finger from *c*; but when *d* was made positive the sparks from *c* were 10 millims. long. The same results are obtained when the finger is brought near *a*, so long as *c* remains insulated. If, however, *c* be connected with earth by a wire, no sparks can be got from *a*, whichever way the current passes between *b* and *d*. Connecting *a* with earth diminishes the length of the sparks, which can be drawn from *c* by about one half.

The poles, *a* and *b*, being connected with the coil, and the idle poles, *c* and *d*, having loose wires hanging from them, the wires were strongly repelled from each other.

The above experiments show that an idle pole in the direct line between the positive and the negative poles, and consequently receiving the full impact of the molecules driven from the negative pole, has a strong positive charge.

It now became of interest to ascertain whether the trajectory of the molecules suffered any deflection in passing an idle pole when it was suddenly uninsulated by an earth contact. For this purpose I used the tube described in a former paper,* where the shadow of an aluminum star was projected on a plate of phosphorescent glass So long as the aluminum star is insulated, the shadow is sharp, as already described; but on touching the star to earth, the shadow widens out, forming a tolerably well defined penumbra outside the original shadow, which can still be seen unchanged in size and intensity. On removing the earth connection, the penumbra disappears, the umbra remaining as before. The same penumbra is produced by connecting the idle pole with the negative pole through a very high resistance, such as a piece of wet string, instead of connecting it with earth. On bringing a magnet near the negative pole, the shadow of the (insulated) star is much increased in definition, the adjacent luminous parts of the screen becoming more luminous. Touching the star now brings a large, somewhat blurred, penumbra round the original image. The penumbra obeys the magnet the same as the umbra.

The aluminum star was now made the positive pole, the other pole remaining unchanged. The shadow of the star was projected on the phosphorescent plate of the same sharpness and almost the same intensity of light and shade as if the positive pole had been the one ordinarily used as such. The image obeyed the magnet as usual. With this arrangement the penumbral action could not be tested.

This, therefore, confirms the above-described results—that the idle pole, the shadow of which is cast by the negative pole, has strong positive charge. Now the stream of molecules must be assumed to carry negative electricity; when they actually strike the idle pole they are arrested, but those which graze the edge are attracted inwards by the positive electricity, and form the shadow. When the idle pole is connected with earth its potential would become zero were the discharge to cease; but, inasmuch as a constant positive charge is kept up from the passage of the current through the tube, we must assume that the potential of the uninsulated idle pole is still sufficiently positive to neutralize the negative charge which the impinging molecules would give it, and leave some surplus of positive. The effect of alternately uninsulating and insulating the idle pole is therefore to vary its positive electricity between considerable limits, and consequently its attractive action on the molecules which graze its edge.†

Experiments were tried with an idle pole and shadow tube while the exhaustion was going on. At such a rarefaction that the shadow can just be made out, it is quite sharp; touching the idle pole causes a small penumbra to appear round its shadow. When the exhaustion is at the best point for obtaining the green phosphorescence on the glass, the shadow is very sharp and well defined; and connecting the idle pole with earth gives a much wider penumbra, the width of the penumbra increasing with the degree of rarefaction. When the vacuum is so high that the spark has difficulty in passing, the penumbra (which becomes visible on insulating the idle pole) is much wider than before, and apparently eight or ten times as wide as it was at the lowest exhaustion at which observations were taken.

If the object whose shadow is cast on the screen is a non-conductor (such as a piece of glass rod), its shadow remains constant at all exhaustions, no penumbra being visible, as it cannot be uninsulated.

Professor Stokes, whose suggestions throughout the course of this research have been most valuable, considered that much information might be gained by experimenting with an apparatus constructed in the following manner: the two poles of the tube (Fig. 9) are at *a* and *b*. At *c* is a

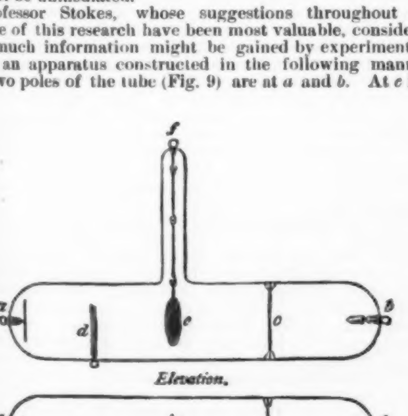


FIG. 9.

fluorescent screen; *d* is a fixed bar of aluminum, and *e* is another aluminum bar hanging from a platinum pole, *f*, by a metal chain. The bar and pendulum are on opposite sides of the horizontal axis of the tube, as shown in the plan, so that when properly exhausted and the pole, *a*, made negative, the shadows of bar and pendulum shall fall side by side on the screen, as shown in Fig. 9 A. On swinging the pendulum, the shadow alternately overlaps and recedes from the shadow of the bar (Figs. 9 B and 9 C).

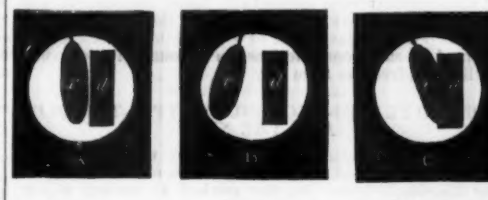


FIG. 9 A. FIG. 9 B. FIG. 9 C.

This apparatus was tried many times with an induction coil, and also with a Holtz machine; but the results were not sufficiently definite to render it safe to draw any inference from them. By the kindness of Mr. De La Rue I have lately had the opportunity of experimenting with his large chloride of silver battery, and the results now come out with great sharpness and with none of the flickering and indecision met with when working with an induction coil.

The tube was so adjusted that the pendulum hung free, and a narrow line of molecular discharge passed between the edges of the bar and the pendulum, forming a line of light between the two shadows of the screen (Fig. 9 A). When the pendulum was set swinging, and the idle pole, *f*, connected with it was kept insulated, the regular appearance of the moving and fixed shadows was very slightly interfered with. That is to say, the shadows followed the successive positions between those shown in Figs. 9 B and 9 C almost as if they had been cast by a luminous point in place of the negative pole. As the shadow of the swinging pendulum came very near that of the bar, the latter shadow seemed to shrink away, showing that the pendulum itself exerted slight repulsion on the molecules which passed close to its edge.

The pendulum was again set stationary, as shown on the plan (Fig. 10), the line of light separating the two being

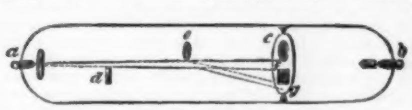


FIG. 10.

at *f*, so that the appearance of the screen was as shown at Fig. 9 A. The pendulum pole was then connected with earth, and instantly the line of light which separated the poles moved from *f* to *g*, through an angle, measured from *e*, of about 30°, the shadow widening out and getting indistinct at the same time.

When the pole, *a*, was negative, and *b* positive, the bar, *d*, and pendulum, *e*, were each found to be positively electrified. The outside of the glass tube, both near the negative pole and near the positive pole, was also positively electrified.

The above experiments were tried with 6,300 cells, a resistance equal to 800,000 ohms being interposed. The current through the tube was 0·00383 weber. These measurements were taken by Mr. De La Rue, to whom I am greatly indebted for permission to experiment with his magnificent battery, and who himself kindly assisted me in making the arrangements.

WILLIAM CROOKES.

* "Phil. Trans.," 1879, vol. 170, p 147.

† I am aware that the theory which makes these effects of deflection depend on electrostatic attractions and repulsions is open to some grave objections; still it was that which in a great measure guided me in my experiments, and it could not well be omitted without reducing the description of them to a dry record of apparently unconnected facts.

ENLARGED COLLODION TRANSFERS.

THIS class of photograph has of late years come much into vogue with the public; but, unfortunately, there are few photographers who know how to produce really fine specimens. It will be the object of the writer in the following remarks to explain, as clearly and succinctly as he can, the whole mode of procedure, so that any one who knows how to take a good negative will be able to secure an enlarged positive from the same, and as perfect as the character of the negative will permit.

1.—THE OPTICAL APPARATUS.

For enlargements from 12×10 up to 25×20 inches, the ordinary portrait combination of from five to eight inches focal length will suit all requirements for the *carte de visite* and larger size of negatives which may require to be operated on. A sliding-body camera about eight inches square is inserted in a hole in the side of a building in such a way that the open end looks toward the sky. If this opening is facing the sun, it will be necessary to interpose a plate of ground glass to subdue the glare of light which would otherwise fall on the negative to be enlarged. The order of arrangement, then, is simply this—the negative faces the light, the space between it and the lens varying according to the size of the desired enlargement.

At a suitable distance from the lens, in order to receive the image, there is placed a movable framework, which may be a painter's easel or any other arrangement; but this must be in such a position that the axis of the lens falls perpendicularly on it. A sheet of white cardboard, cut to the size of the enlargement, makes a capital focusing screen. Thus it will be seen that the room in which the enlargement is made itself constitutes the *camera obscura* of the operator, inasmuch as therein all the manipulations are conducted.

2.—THE CHEMICALS.

A good *old* collodion is best suited for this class of work; still a newer sample may be made to answer equally well, if sufficient tincture of iodine be added till the color reaches a dark sherry tint. This certainly tends to prolong the exposure; but at the same time the resulting pictures are far more brilliant. The usual negative collodion is rather too heavily iodized for a weak sensitizing bath; therefore, three to four ounces of plain collodion added to each pint is advisable in most instances.

The silver sensitizing solution is to be prepared precisely in the same way as for negatives, with this exception: that it should never register more than twenty grains of silver to the ounce of water. In warm weather it may be worked down as low as fifteen or even twelve grains to the ounce without sensibly impairing the quality of the work. A flat glass or porcelain trough for holding the solution, and having a string placed across the bottom for raising the sensitized plate, is preferable to a dipping bath.

The developer is made in the following proportions: Three grains of pyrogallic acid; two to three grains of citric acid, according to temperature; one ounce of water; and alcohol to induce the solution to flow more even over the plate.

The best fixing solution is a strong one of hyposulphite of soda in preference to cyanide of potassium, as the latter is apt to weaken the image. Yet it is well to have a rather strong solution of cyanide by you, because it will often clear up a haziness of the high lights which the hyposulphite fails to reduce. But the application of this must be done with great caution, and in some instances only locally.

The glass plate, in order to be fitted for receiving the image, after being thoroughly cleansed as usual, is first spattered over with a little alcohol, rubbed with a clean cloth, and after being dusted with powdered talc, again rubbed. Any loose particles of talc adhering are removed by a broad camel's-hair brush. The collodion is then poured on and allowed to set for rather a longer time than is generally done for negative work before being immersed in the nitrate bath. As the latter is preferably made weak, longer than the usual time is required for full sensitizing. This point, however, can be ascertained in the ordinary way by observing when the fluid flows evenly over the surface when drawn up. After draining for two or three minutes, the sensitized film is placed in the position occupied by the focusing screen to undergo exposure.

The proper time of exposure in this process, as in all other photographic processes, is of the utmost consequence. The symptoms of over-exposure are very much of the same character as those exhibited in the development of negatives, but even more marked; so also in the case of under-exposure. For a negative of average density, subjected to a strong diffused light and without a diaphragm in the lens, from four to six minutes' exposure will generally be sufficient; but in very dull weather the writer has often seen half an hour's or even a longer exposure insufficient for the purpose. But in this as in other photographic processes no definite rules for exposure can be rigidly adhered to. The experience of an observant operator will soon make for himself a good practical actinometer, if he carefully mark the indications of the next process.

The Development.—When the exposure is considered sufficient, the plate is placed on a leveling stand and the developing solution poured rapidly over the film, so as to run over the whole without a pause at any point. The plate is then rocked about occasionally, keeping the solution in motion so as to promote uniform action. In about a minute the image will begin to appear, and in from two to four minutes more will be brought up to the requisite strength for a good positive impression. Swill the plate hastily with a little water, and plunge at once into the hyposulphite fixing-trough.

If the progress of development be more rapid than the time above indicated, one or other (perhaps both) of two faults has been committed—either the exposure has been too long or the developer is too concentrated. Generally the former is the case. In such circumstances the remedy is obvious; but also when operating in a hot room the developer may act with such powerful energy as not to be controlled and stopped at the exact instant required. In this case reduce its strength by dilution by water, and add a little more citric acid and alcohol.

After the image has been fixed in the hyposulphite bath, examine it carefully by transmitted light for transparent or opaque, small, irregularly shaped blotches, which often occur in this process. In the dress such spots, unless large and numerous, are not of much consequence, as they can afterwards be filled in or removed; but in the face they are fatal, or ought to be, and the work must be done over again. Although the writer has given much attention to these blemishes, he has failed utterly in ascertaining the cause. Sometimes, whilst cropping up with every successive plate for a few hours, they will all at once cease appearing, and that, too, without changing the chemicals or other conditions, except that of weather, which is not under our control.

When fixed, a thorough washing is, of course, essentially necessary. Now commences what is called the transfer process from the glass to specially prepared paper, which is thus made:

In a clean pot or saucepan soak ten ounces of gelatine in a gallon of cold water for two or three hours. Apply heat gradually till the gelatine is dissolved, taking care that the temperature does not rise above 180° Fahrenheit or thereabouts. Add two ounces of chrome alum, and while the solution is still warm filter it through a flannel or canvas bag into a flat-bottomed porcelain tray, so placed that by means of a gas or other warmer placed underneath the gelatine will remain fluid. Now commence to float on it, exactly as in sensitizing for ordinary positive printing, the paper which may have been selected for the work. Thick Rive and Saxe are, perhaps, the best to use. In laying the paper down it is very difficult to avoid air-bubbles on account of the viscidity of the solution. These, however, are of little consequence, as, when removing the sheet, any faults can be filled in with a camel's-hair brush dipped in the warm solution. On account of this viscid nature the sheet is apt to curl up at the edges while lying on the solution. Small blocks of wood placed on the top will keep the curls down. From one to two minutes for floating will be amply sufficient. The sheets, as they are removed from the gelatine, are drawn over a glass rod or the edges of the dish to spread the solution evenly, and hung over wooden rollers to dry in a rather warm room.

To Transfer the Picture.—While the collodion film adhering to the glass is still quite wet from the washing water, a piece of transfer paper rather larger than the glass, and which paper has been soaking for a few minutes in cold water to soften the gelatine, is laid down on the film and gentle pressure applied backward and forward with the edge of a soft India-rubber *squeegee*, such as is used by carbon printers, till perfect contact is secured. If too much pressure be employed, or if the collodionized plate has been immersed too soon into the silver sensitizing bath after being coated, the film will be broken by the squeegee, however soft, in places; and, in consequence, the picture destroyed. The superfluous paper round the edges is scraped off by means of a small strip of glass. Then the whole is set aside to dry in a uniform but not too high temperature. The heat of a comfortable sitting-room is about the correct standard. In such a case the transfers of the day will be ready for stripping the next morning.

To strip them run a pallet knife edgeways down two of the sides of the plate between the picture and the glass, and, raising the loose corner with the hand, gently pull off the picture by turning it backwards. If all the conditions have been fulfilled, it can thus be stripped from the glass without the least difficulty. When a picture does stick in places, do not attempt to use force, as by so doing it will inevitably be

torn. Yet by soaking the whole for a few minutes in cold water, the transfer will generally, by careful handling, be capable of removal from the glass.

The reasons why transfers sometimes obstinately refuse to leave the glass at some points are several. The glass may have been imperfectly rubbed with talc before applying the collodion. After being papered up, the picture may have got too dry or it may have dried more in one place than in another. Or, again, the development may have been continued too long, in which latter case the deposit on the deepest shadows is of a rotten, spongy nature, and partly adheres to the glass and partly to the transfer paper.

Concluding Remarks.—Some operators recommend that the sensitizing bath should be made stronger than above indicated. The writer does not join in this opinion; for, after much experience, he finds the weaker solution to give finer results in every respect. A good plan to keep the silver bath up to uniform condition and strength, when it is working well, is to have a non-iodized stock of silver solution registering about twenty-five grains to the ounce, so that when the bath is impoverished and lessened in bulk by frequent use it may be kept up to its original quantity and strength.

Again: it may be asked, Why not develop with protosulphate of iron instead of pyrogallic acid? Certainly, this plan may be adopted, but the tone of the resulting picture is not so pleasing, and, besides, the deposit is of a more granular character.

In finishing the glass plate before collodionizing some operators prefer to rub the surface with a saturated solution of beeswax in cold ether or turpentine instead of powdered talc or French chalk. The only objection to this method is that the collodion is apt to *drag* in the course of coating the plate, thus giving rise to a lumpy surface, which often, although not always, means uneven development. Yet if there should be exhibited a persistent tendency of the compound film to *stick* in the course of removal from the glass support, this mode of procedure with wax will generally cure the evil, provided the other conditions are fulfilled.

Should the writer have failed to make any portion of the above description quite clear to any reader, he will be glad to supplement his remarks in an early number of this journal. —*George Dawson, M.A., in British Journal of Photography.*

SOME EXPERIMENTS WITH ASPHALT FOR PHOTOGRAPHIC PURPOSES.

By J. O. MORCH.*

IN the appendix to the second edition of Husnik's "Manual on Collotype Printing" (*Gesammtgebiet des Lichtdrucks*) are some instructions for the preparation of a sensitive solution of asphalt founded on the researches of Dr. Kayser. The general principle consists in purifying finely-powdered asphalt of the noxious constituents by separation with ether. A solution of this kind is already produced commercially, and its sensitiveness is very satisfactory. I had succeeded in purifying asphalt by another method, which I now proceed to make known.

In the first place, I select a suitable kind of asphalt, which may be known by the following peculiarities. The powdered asphalt must have a deep chocolate color, without any tinge of yellow; it must not be soluble to any extent in turpentine; its melting point must be as high as possible—not less than 100° C. Having obtained such an asphalt, I make a tolerably concentrated solution of it in chloroform, in a good sized flask. When it is all dissolved, I add three times its volume of ether, shaking well during the process, and let it stand for two days. The ether throws down the sensitive constituent of asphalt; so I collect the precipitate on a filter, dry it thoroughly in the dark, and then dissolve it again in coal tar benzole.

As regards the development, it is to be observed that it is very difficult to control, in consequence of the rapidity with which it takes place. In order to be better able to watch this part of the process, I always let the plate cool before proceeding to develop, as, in consequence of its exposure to the direct rays of the sun, it is liable to become heated. Besides this, I mix a few drops of balsam of Peru with a sensitive solution of asphalt, somewhat in the following proportions:

Asphalt dissolved in 150 cub. cent. of benzole, 10 grammes, with the addition of—
Balsam of Peru .... 5 centims.

With this solution I am able to keep the development tolerably under control.

In this operation I find it most convenient to follow Husnik's directions with oil of turpentine and subsequent washing with spirit. Generally I use the following formula:

Coal tar benzine	20	grammes.
Spirit of turpentine	50	"
Methylated spirit	100	"

and this quantity serves me for many plates. When the solution is complete, I rinse well, first with spirit, and then under the water tap.

Should the plate be over exposed, so that fog shows itself in the high lights, the plate must be washed, dried, and then warmed to a temperature of from 45° to 50° C., and finally have the developer again flowed over it; the drawing will then reappear quite clear in the places where it was previously fogged. Rubbing, or even gently passing a brush over the plate, I cannot recommend, as the drawing is so liable to injury.

If I have time, I generally expose the plate after development as long as possible to direct sunlight, in order to heighten as much as I can the insolubility of the film, and by this means the protecting power is considerably augmented. The shadows, which, when the transfer is etched, print generally of so gray a tone, on account of the etching fluid having worked through the coating, have, when this operation is resorted to, a fine black color, and this contributes considerably to the excellence of the result.

When the asphalt process is in skilled hands it does not deserve the objections of uncertainty, slowness, and costliness that have been raised against it. On the contrary, it possesses in many respects great advantages over the chromate process. Especially the transfer printing is avoided, as well as the continual blackening of the plate with a sponge, and the time consumed in these manipulations is now so much gain. Besides, the results, more especially in the case of reductions, are much finer. The strongly adhering layer of asphalt protects, as has already been remarked, better than the best color, including the powder method.

For the production of etchings on glass, inscriptions on metal by the etching process as well as for design rollers, the sensitive film of asphalt as a protective coating may always be used with advantage. Recently I have by means of the asphalt process successfully taken transparent positives for the lantern, being copies of the illustrations of various books of travel, and have found them to be specially adapted for such reproductions, on account of their sharp outline and freedom from fog.

* *Photographische Notizen.*

PHOTO-PLATES—WOODBURY-TYPE—THE OLD AND THE NEW.

WE must congratulate Mr. Woodbury upon the success which has rewarded his efforts to reduce photo-relief printing to a simple form. As the method at present stands, with the last finishing touch that has just been given to it, no process of photo-engraving could be more easy or practical. Within a twelvemonth, Woodbury-type has not only become untrammeled by patent, but robbed of every complication that stood in the way of vulgarizing the process. We shall not be surprised, after this, if, when another year has passed, many photographers—or, at any rate, those in the first rank—take to producing their pictures by mechanical means instead of by sunlight, and exchange the frame for the press in their printing department. Already we hear of several Paris houses that have taken up photo-relief printing, while far-off Madrid, it is said, has sent representatives to the French capital to learn if the good news be true.

The lapse of the Woodbury-type patent in England caused several in this country to take up photo-relief printing. Besides those directly interested in the patent may be mentioned the Autotype Company, and the London Stereoscopic Company, as among the first to recognize the value of the process. We all of us know the orthodox method of proceeding. A gelatine pellicle, slightly tinted, but still transparent, was sensitized in a solution of bichromate, and, after drying, exposed under a negative. The surface thus reprinted, having been rendered partially insoluble—where the light had got to it through the negative—was then washed in lukewarm water, the result, of course, being an intaglio, or image represented by hollows, more or less deep. This intaglio or mould, when dried and hardened, was put at the bottom of a shallow steel tray, the walls of which were knife edges; a sheet of lead was placed upon the mould, and the whole put under a hydraulic press. Enormous pressure was necessary. In the case of a carte-de-visite picture a pressure of something like 150 tons was required, while in the case of a picture measuring eight or ten inches, no less than a strain of 500 tons was deemed requisite to force the lead into the cavities of the gelatine image. The knife edges cut through the lead, and thus allowed the latter to fill up the tray precisely, a measure indispensable to prevent injury to the gelatine mould.

In this way, then, the engraving plate that served for the printing off of Woodbury-type impressions was made. Not only are the operations very delicate and nice in their nature, but they involve much time and costly apparatus. The mere fact that a hydraulic press, capable of exerting a pressure of from 150 to 500 tons, is a necessity, was of itself sufficient to prevent Woodbury-type being worked by photographers at large, and it was for this reason why only large firms could afford to practice the process. Now Mr. Woodbury shows us how press, steel tray, lead, and hydraulic machinery may be dispensed with altogether, and any photographer who possesses a rolling press and a supply of tin foil can prepare a properly engraved plate. The modification is so simple that it seems absurd the plan was not thought of before. Mr. Woodbury takes a positive instead of a negative to begin with, and with this produces his gelatine mould. This mould is hardened as before, attached the while to a surface of patent plate, so that its level character may be depended upon. As soon as dry, a sheet of tin foil is placed upon the gelatine mould, and, to force the thin metal securely into every crevice, mould and tin foil are sent through an ordinary rolling press. This is all. The gelatine mould with its lining of lead—for tin foil, as our readers know very well, is simply sheet lead—serves for printing off the Woodbury pictures, and to judge from the appearance of the prints with which Mr. Woodbury has favored us, the impressions are equal in every respect to those furnished by moulds in which the lead is solid.

Of course there is the making of the gelatine mould in the first place, and the actual printing off of the impressions in the last, and to do these operations well and successfully, some apparatus and some experience are necessary. The experience can obviously only be acquired by practice, but we have no doubt that Mr. Woodbury will see his way to giving instructions as to apparatus and manipulations to British photographers in the same manner as he affords assistance to those abroad. Mr. Woodbury, we believe, is bound by some engagement or agreement not to do any teaching in the matter of photo-relief printing in this country, and hence it is that the important improvements he has recently made known come to us from abroad. The business arrangement between Mr. Woodbury and his co-operators do not, however, concern us, and our duty here is but to chronicle the simple and easy stage to which photo-relief printing has now been brought.—*Photographic News.*

A NEW DEVELOPER.

By CAPTAIN W. DE W. ABNEY, R.E., F.R.S., etc.

SOME two years ago I began a series of experiments on developing agents, with a view of finding some one which would only act on the silver bromide which had been acted upon by light, and not on silver bromide as well. Now every one is aware that the ordinary alkaline development (except by a *tour de force*) acts upon silver bromide unless a restrainer or retarder such as gelatine or soluble bromide be at hand during the development. Except in the case of albumen beer plates in the form which I originally introduced, no collodion film, as far as I am aware, could be treated with pyrogallic acid and ammonia without a hopeless fog ensuing. In this case the albumen acted very much like gelatine does in the gelatino-bromide plates, and this process is therefore no exception to the rule. The most crucial test for a developer is to apply it to a plate coated with ordinary washed collodio-bromide emulsion, the film having no preservative. There are several organic substances which can be applied as preservatives, and which, when ammonia is applied, will cause a faint image to be developed; but intensity is always wanting. It would scarcely interest my readers to give the theoretical reasonings which led me to try a substance which is but little known, viz., hydrokinone. It is sufficient to say that, as a developing agent, it is very perfect, and can be used in a collodion emulsion film without the slightest trace of restrainer or retarder; in other words, it requires no soluble bromide with it.

Hydro-kinone is a derivative from kinone, and, on the addition of certain metallic compounds to it, acts as a reducing agent. It is soluble in alcohol, and in water to a large extent. The following experiments are worth a trial. Dissolve one grain in two drachms of water, and expose a collodio-bromide plate for half the time necessary with the ordinary alkaline developer, and apply this quantity of liquid with one drop of strong ammonia. The image will appear quietly, and show all detail, but on fixing will be rather too feeble; it will take silver intensification, however, perfectly. Double the quantity of hydro-kinone, and again develop a plate, and it will be found that the intensity is of a medium character, while, by trebling it, it will be found that proper density is secured. With gelatine plates the same experiments may be repeated, a less quantity being apparently requisite to give proper printing density than with collodion films. On fixing the plates they will be found perfectly free from any veil caused by a reduction where no reduction should be, and they will give brilliant prints.

It may be asked if the hydro-kinone has any advantage over the ordinary alkaline developer. I am inclined to think it has—in that the faintest trace of the action of light is made apparent, and is not destroyed by the soluble bromide. This should be a decided gain, and on testing it against ferrous oxalate (without bromide) in gelatine plates, it seems as if this were borne out. With collodion plates it has a decided advantage, and it may be worth a trial. A curious experiment is to prepare a collodion plate, wash it, and pour over it a solution of hydro-kinone and ammonia, and then expose in the camera; it will be found that development commences during the exposure; whereas such an attempt made with ordinary alkaline or ferrous oxalate developer would prove a failure. The great objection to the use of this compound is its price; it is expensive, but doubtless any demand for it would quickly reduce it to nearly the same price as pyrogallic acid. It is at present more a chemical curiosity than of any commercial use, but if it should prove to be a good developer, it would speedily find its way into the price list of manufacturing chemists at a more moderate rate than that at which it is now shown.

THE LIVADIA.

WE illustrate on the following pages the Livadia, built as a yacht for the Czar, and launched on July 7, 1880, at Govan. A special meeting of the Fairfield Association was held in the Fine Arts Institute, Sauchiehall street, on June 30, when a paper was read by Captain E. E. Goulaeff, naval architect, Russian Imperial Navy, on "The Fairfield Yacht for the Czar, and Vessels of Her Type considered as Means of International Communication." Our engravings, taken with the following description prepared from this paper, will make her construction clear. The vessel is 235 ft. long, 153 ft. broad, and has a draught of 6 ft. 6 in. She might have been a little longer, but on closer investigation it was found that the addition of some 25 ft. or 30 ft. to her length would not have reduced the resistance in water. She might have been a little narrower to suit the taste of most people, yet, says Capt. Goulaeff, "the beam of 153 ft. cannot be regarded as being too great, if we bear in mind the main object of her design, namely, the desire to secure the greatest steadiness." Her small draught is, perhaps, the most peculiar of her features. Experimental analyses, agreeing with the actual results derived from the trial trips of extremely broad vessels existing in the Black Sea, prove that, at certain speeds, a very much broader vessel required only half as much power compared with another vessel of similar form whose draught is double. In fact, the principal proportions of the yacht could scarcely be altered in any way to the advantage of the ship. A large superstructure has been built upon the main body of turbot shape. This superstructure is of the shape of an ordinary vessel, and being of the usual form, will no doubt gratify the eye of those who are not sufficiently educated to admire the uncovered sides of the lower turbot portion of the ship, which, however, were the very parts that had the greatest share in limiting the rolling at sea. The turbot-like lower part of the vessel contains machinery, coal, and stores of all kinds. The steel superstructure rising over it contains accommodation for the crew forward and for the officers aft, while the palace beyond it includes only the imperial apartments and the cabins for the suite.

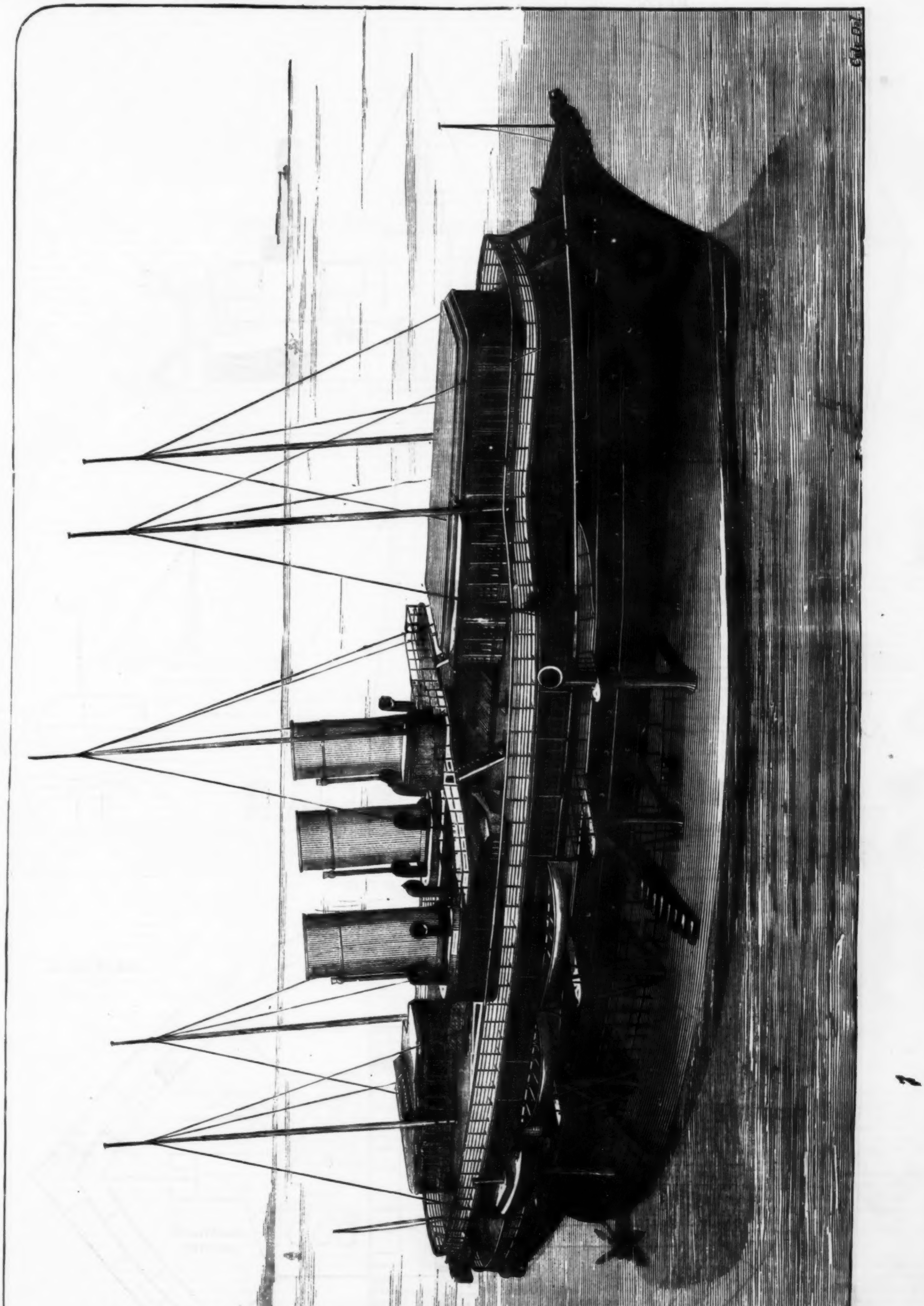
The turbot-like portion is built of steel, with a double bottom, whose height is no less than 3 ft. 6 in. in the center. This double bottom is divided into forty water tight compartments, and extends throughout the flat portion of the bottom. At the sides it is superseded by the cells formed by running two vertical bulkheads right round the ship, and subdividing the distance between them and the outside skin into forty other compartments. These side cells, formed of continuous bulkheads, and covered by the plating of the rounded deck, present a very rigid, continuous, annular structure, which has its lower points tied together by the radial girders forming the bracket framing of the bottom, and by the heavy beams of the rounded deck, also radial, at the top.

Thus the turbot-like portion is made amply strong enough to withstand those forces which might be experienced in the roughest seas, and the local strains, such as those produced by the powerful machinery with which the ship is provided—particular attention being paid to the structure of the stern, in order to distribute the strains on the brackets supporting the propelling shafts of the side screws.

The palace is not so wide as the steel superstructure, so that all around it on the deck a continuous gallery is formed, which is used for stowing anchors, mooring the vessel, hoisting up boats, steam launches, and a small steam yacht carried on the davits, which are supported by bridges projecting radially outward from that gallery. The roof of the palace is carried right over to the same width as the lower superstructure, thus forming an awning over the gallery, shading from sun or rain the lower story of the palace, and widening at the same time the promenade above.

Inside the lower story, forward, and away from the heat and smell of the engines and galleys, are the apartments for the Emperor, and aft those for the suite.

Beyond the promenade, on the awning deck, is a reception saloon, whose height is 12 ft., and, therefore, greater than has been reached on board any other ship. In its forward part will play a fountain, surrounded by a bed of flowers. The whole decorative works of this saloon remind them, said Captain Goulaeff, of the rooms of Louis XVI. at Fontainebleau, and the designs of this and other apartments were prepared by the well-known Scotch artist, Mr. W. Leiper. The drawing-room will be furnished in Crimean-Tartar style, while other rooms will be of a simple kind of modern English. Behind the funnels on the same awning deck stands another deck house, including rooms for the Grand Duke Constantine and the captain of the

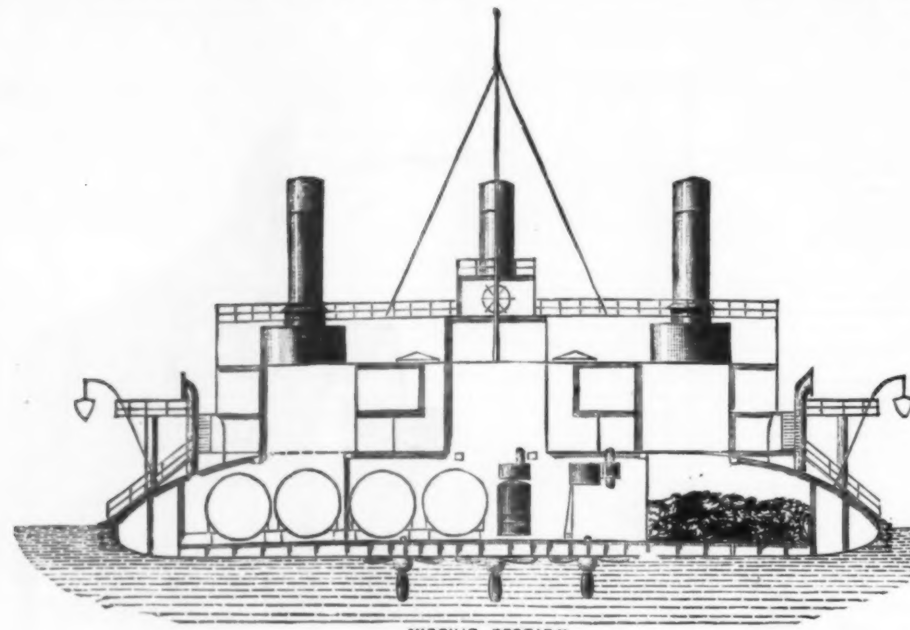


THE LIVADIA.

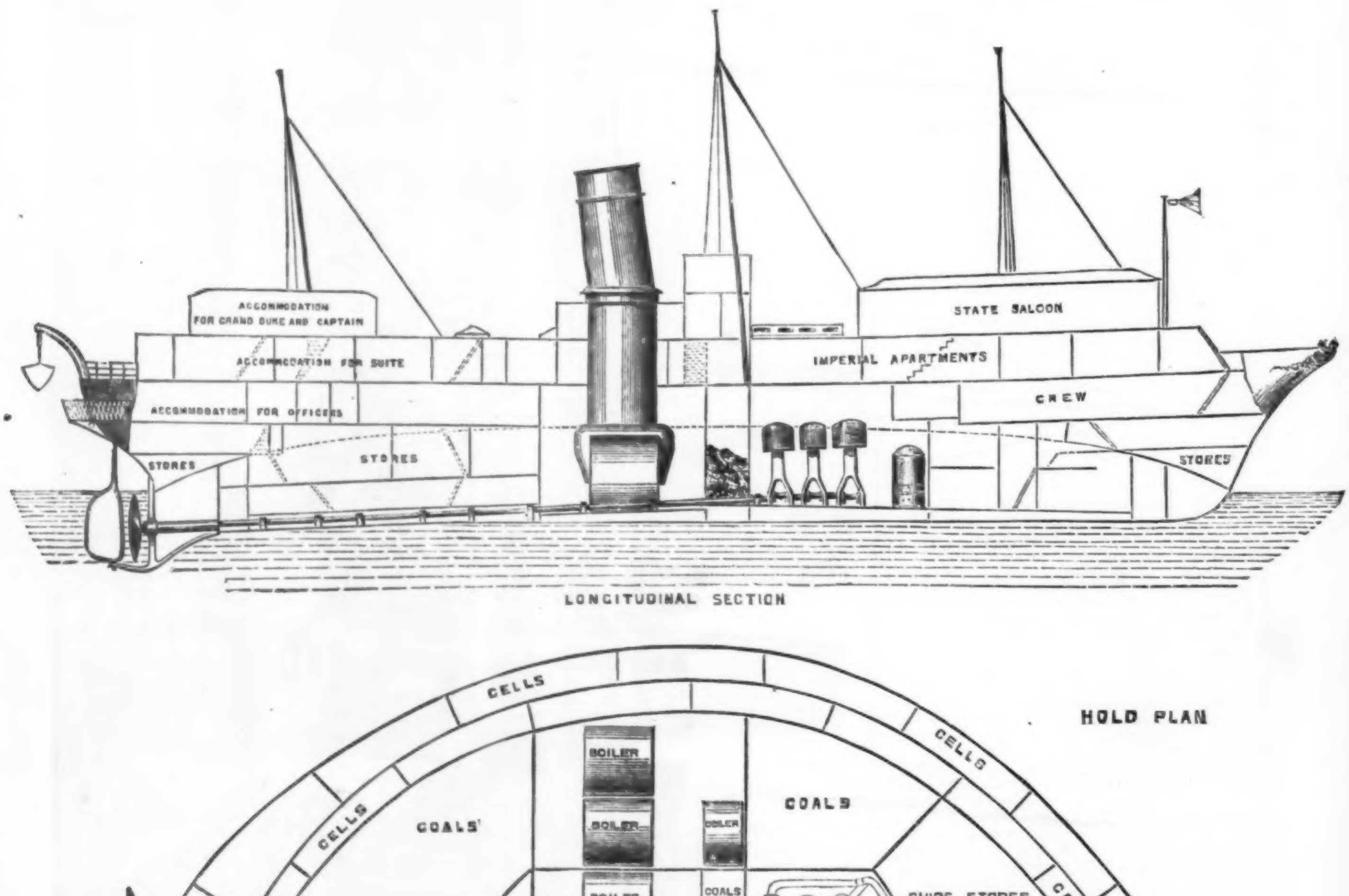
MESSRS. JOHN ELDER & CO., BUILDERS AND ENGINEERS, GOVAN.

THE LIVADIA.

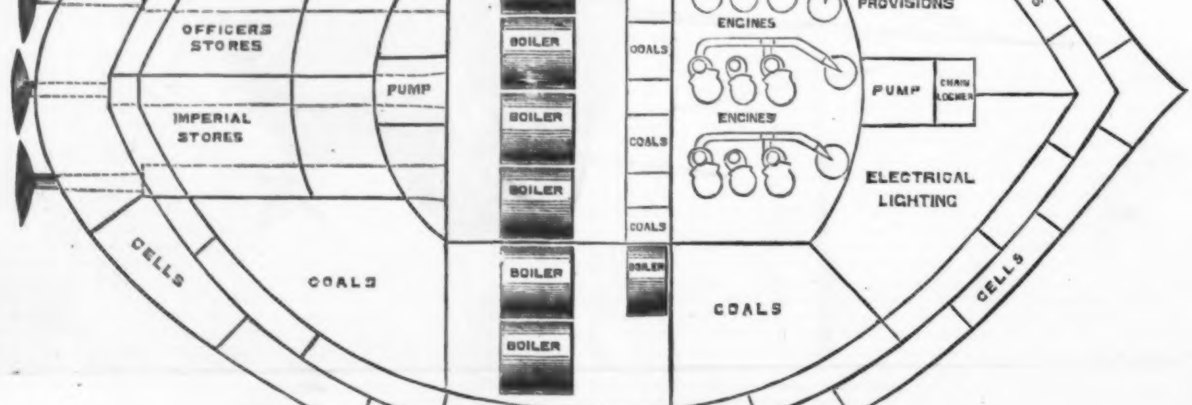
MESSRS. JOHN ELDER & CO., BUILDERS AND ENGINEERS, GOVAN.



MIDSHIP SECTION.



LONGITUDINAL SECTION



HOLD PLAN

ship. Just in front of the funnels is the bridge, from which the ship will be governed, either by the steam-steering gear acting upon her rudder, or by means of another gear designed for steering the vessel by means of her side screws.

Machinery has been employed largely to supersede manual labor, and there are no fewer than twenty-three separate steam engines on board for different purposes. The propelling engines of the yacht, designed by Mr. A. D. Bryce, are of a construction decidedly novel, and have been erected in a somewhat novel manner. Their foundation, which is of steel, forms part of the framing of the double bottom. Captain Goulaeff discussed at some length the question of vessels of the Livadia's type considered as a means of international communication, and in his concluding remarks said: "Three sides and the double bottom would prevent the ship from sinking should she be seriously damaged by collision or stranding, and three independent engines would insure the possibility of navigating the ship to the place of her destination with one or even two engines broken down—an advantage of which not one of the existing steamers could boast. After losing the rudder the yacht was not left helpless—she could be handled as well by steering her by the side screws."

One of the most interesting questions concerning this ship will be her speed; and there is so considerable a departure from the proportions and form of the circular ironclads, and at the same time so limited an approach to the form of even the broadest of existing ships, that there are available for comparison little data of a really reliable character. The displacement of the Livadia is 3,900 tons, obtained upon a length of load water line of 230 ft. × 153 ft. and 6·5 ft. in breadth and draught, giving a displacement coefficient of 0·6 nearly. This latter figure points to comparatively fine lines, and, indeed, the buttock lines have been so made as to give extremely fine vertical entrances and runs to the form of the ship; although the profile and midship section, might lead to the conclusion, if viewed apart from the sheer plan, that the vessel had a flat bottom prevailing for nearly the whole of her length and breadth. It is evident, therefore, that every effort has been made in the design to facilitate the passage of the vessel through the water by a greater proportion of vertical displacement and replacement, as distinct from the same action horizontally, than would be possible in any other vessels, excepting, perhaps, the circular ironclads. It is possible that the peculiar action thus produced by the propulsion of the latter vessels, added to their coincidence of ship and wave period, had much to do with the cause of their tendency to depress the bows and even to drive under if driven at speed—a peculiarity which would undoubtedly prevent their attaining high speed even if supplied with sufficient power.

Let us compare the proportions and speed performances of several known vessels whose construction has marked successive stages in the recognized system of building for war purposes short and broad ships. The Warrior, designed after the then accepted proportions of the ship-like form, viz., 6½ to 1, had a length of 380 ft., a breadth of 58 ft. 4 in., and displaced 9,000 tons with an immersed midship section of 1,250 square feet; her speed is 14·3 knots, giving coefficients of 230 and 668. The Bellerophon has proportions 5·35 to 1, viz., 300 ft. length and 56 ft. breadth, and displaces 7,500 tons with an immersed midship section of 1,230 square feet; her speed is 14·2 knots, giving coefficients of 168 and 540. The Kaiser and Deutschland are each 280 ft. long and 62 ft. broad, or a proportion of 4·5 to 1; each ship displaces 7,500 tons, and has an area of immersed midship section of 1,350 square feet. Their speed on trial was 14¼ knots, giving coefficients of 134 and 467. The Novgorod, one of the circular ironclads, displaced 2,490 tons with an immersed midship section of 1,170 square feet; her speed is nearly 7½ knots, giving coefficients of 35 and 220.

A comparison of the foregoing figures shows that the proportionate increase of beam from 1 : 6½ to 1 : 4½, if accompanied by moderately fine ends, does not in practice reduce the speed to anything like the extent necessary to counterbalance the advantages obtained from that increase; but that on reaching the circular form the conditions as regards speed are altogether changed; and, indeed, the late Mr. Froude stated at the Institution of Naval Architects that the resistance of the purely circular form of ship is five times that of the ordinary form.

Supposing that, regarding the Livadia as a circular ship of 153 ft. diameter, with fine ends added, to the extent of lengthening her 82 ft., the comparative resistance be taken as decreased by the added length from five times to about three times that of an ordinary vessel—and it could be shown that such an allowance would accord with certain well-established principles—it would be found that the Livadia's speed as compared with the Novgorod's would be about 13½ knots by the corresponding displacement coefficient and 16¼ knots by the corresponding midship section coefficient.

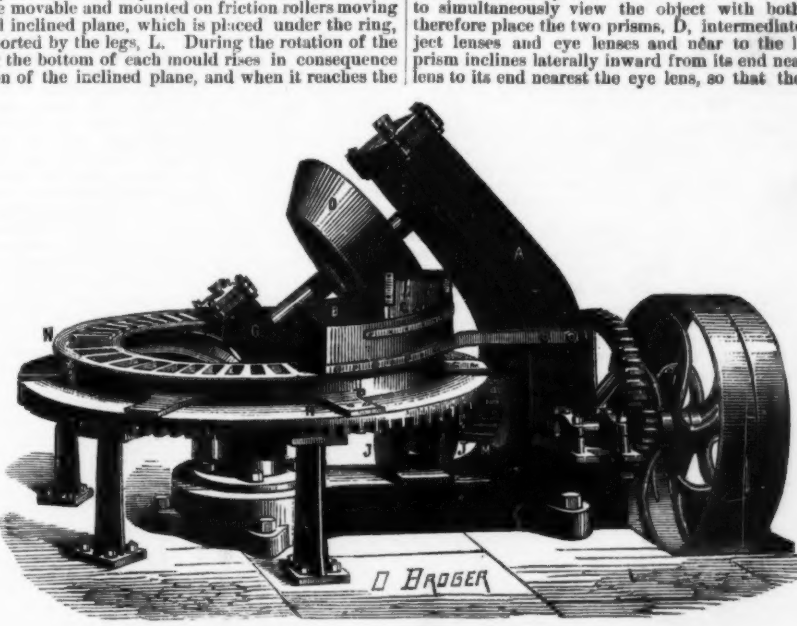
Such comparisons, however, should not be advanced with any degree of confidence, because of the many disturbing influences of which it is impossible to take account. The present position of this important question, therefore, seems to be that while on the one hand the system of broadening vessels, even to giving them proportions as small as 3½ to 1, has met with marked success, on the other hand the bold experiment made in building circular vessels has been a failure as regards speed; and that, if there remain the possibility of still further increasing the relative beam, the distance to which that increase may extend is to be solved by such experiments as the Livadia and in no other way. The proportions of that vessel are 1½ to 1 nearly, and, although such proportions approach far more closely to the circular form, which has failed in point of speed, than to the broad ships above quoted, which have succeeded, it is possible that the addition to the circular form of this amount of comparative length in the shape of fine ends may be sufficiently great to remove the character of the resistance to propulsion far away from that experienced by the circular ship. Upon this point we do not think any one can yet express a confident opinion, although as we have seen there is reasonable ground to hope that the resistance will be much less than that of the circular form; but, in view of the foregoing comparisons and of others that we have made, we are quite prepared to find that the result of the trials will show the Livadia to be better than a 14 knot ship, and that her speed may even approach 16 knots. The trials of the great yacht will, without doubt, indicate with much distinctness the amount of increased relative breadth that is possible with due regard to speed resistance in future ships.

Comparatively good results in steering power may be expected from the Livadia, because her formation under water about a central keel line, and the extension aft of the position of the rudder relatively to the circular ships, must not only improve the action of the rudder itself, but must also give the vessel greater power of changing her actual line of motion than is possessed by the circular ironclads.

Looking at the profile and cross section of the vessel, the supplementary nature of the construction of the "palace," or upperwork containing the accommodation for the Emperor, with officers and crew, is strikingly evident. It will be seen that, starting from the region of the present water line, the upper horizontal boundary of the hull proper rises in a sloping direction to its greatest height in the center of the vessel, and the angle of its slope is, as nearly as may be, the one proper for the successful use of deck armor, and does not greatly differ in the profile view from the outline of the deck armor of the Inflexible. The great extent to which water-tight subdivision has been carried in the hull below this deck is noticeable, and the double line of water-tight cells surrounding the vessel may be taken as a very satisfactory protection against ramming, extending, as they do, 12 ft. inboards at the midship part, and forward and aft a much greater distance than that. The citadel-like subdivisions of the space is the hold, containing nearly one-half the boiler power and the whole of the engines, would also be highly favorable to the rearrangement of the upper part of the vessel when the occasion arises, and there can be no doubt that, by the removal of a portion or even the whole of the upper part of the superstructure of upper decks at present resting upon the vessel, an amount of weight would be gained which would go far to enable her to carry an armored citadel, shaped somewhat like the outline of the bulkheads bounding the central space in the existing hold plan. The displacement per inch at the level of the present load line approximates to 60 tons, and a comparatively slight increase of immersion, added to whatever weight might be saved by the removal of the upper decks, would suffice not only to carry a central armored citadel, but also a sheathing of deck armor, extending from the base of the citadel along the sloping upper part of the hull as far as the water line.—*Engineering.*

ALLEMAND'S BRICK MACHINE.

THIS machine, constructed at the shops of M. Fleury, at Paris, consists of a horizontal, circular casting, I, mounted on a pivot, and having fifty brick-moulds in the periphery of its upper surface. This circular casting is bolted to a second and larger one, H, placed beneath it, and the lower surface of which is toothed and actuated by a rack, M. The whole is supported on the general frame, A, of the machine. This large frame, A, along with the smaller one, G, carries an inclined axle, to which is affixed a conical compressor, D, whose surface rests on the face of the mould-ring, I. The clay is put into the hopper, B, which stands just in front of the compressor, and which is provided with a sliding-gate, C, the object of which is to regulate the pressure of the clay. As a consequence of the rotation of the mould-ring, I, the moulds pass in succession under the hopper, B, and are filled with clay. The compressor, D (the pressure of which is increased by springs pressing against its axle bearings), compresses the clay confined in the moulds; and the amount of such compression is dependent on the tension of the springs and the complete filling of the moulds. In order that the moulds may be automatically emptied, the bottom of each one is made movable and mounted on friction rollers moving over a fixed inclined plane, which is placed under the ring, I, and supported by the legs, L. During the rotation of the mould-ring the bottom of each mould rises in consequence of the action of the inclined plane, and when it reaches the point, N, the brick is pushed out and taken away by the workman. The rollers, J, facilitate the rotation of the wheel and the movement of the bottoms of the moulds, while at the same time they serve to counteract the pressure exerted by the compressing roller. The sliding-gate in the clay trough is opened more or less according to the consistency of the earth used. The clay is placed in the hopper without previous pugging or kneading, according to its nature, and always in its natural state of moisture. The product varies, according to the size of the machines, from 1,000 to 2,000 bricks up to five cubic meters of small beton blocks per hour. The manufacture of bricks by this machine can be effected rapidly and economically; and, owing to the excellent method of compression adopted, the quality of the product leaves nothing to be desired.



ALLEMAND'S BRICK MACHINE.

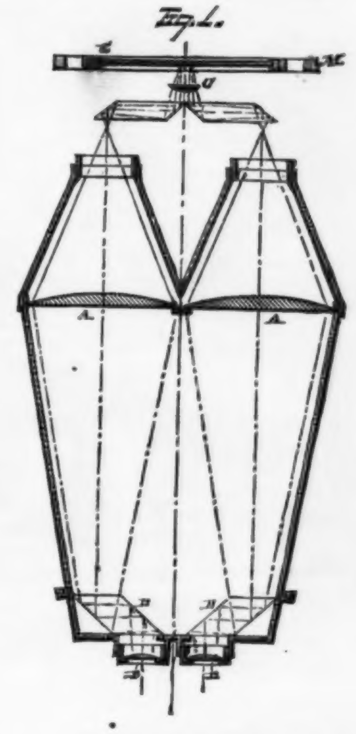
IMPROVED MICROSCOPE.

By EUSEBIUS J. MOLERA and JOHN C. CEBRIAN, of San Francisco, Cal.

THE improvements relate to the optical construction of a binocular microscope, and also to the plate holder employed in presenting the plate of reduced matter to the objective glass.

The invention consists, first, in the combination, with eye lenses and large field lenses, of two intermediate prisms respectively located next to the eye lenses and adapted to bring the two separate images nearer together; second, in the combination with a frame in which a plate holder and its slide are adapted to have independent or joint movement, of an inclosing frame in which said plate holder frame and its slide are adapted to have independent or joint movement, said parts being adapted to permit the plate holder to be adjusted vertically and horizontally by both quick and slow movements.

Referring to the drawing, Fig. 1 is a central horizontal section of one form of microscope embodying the invention.



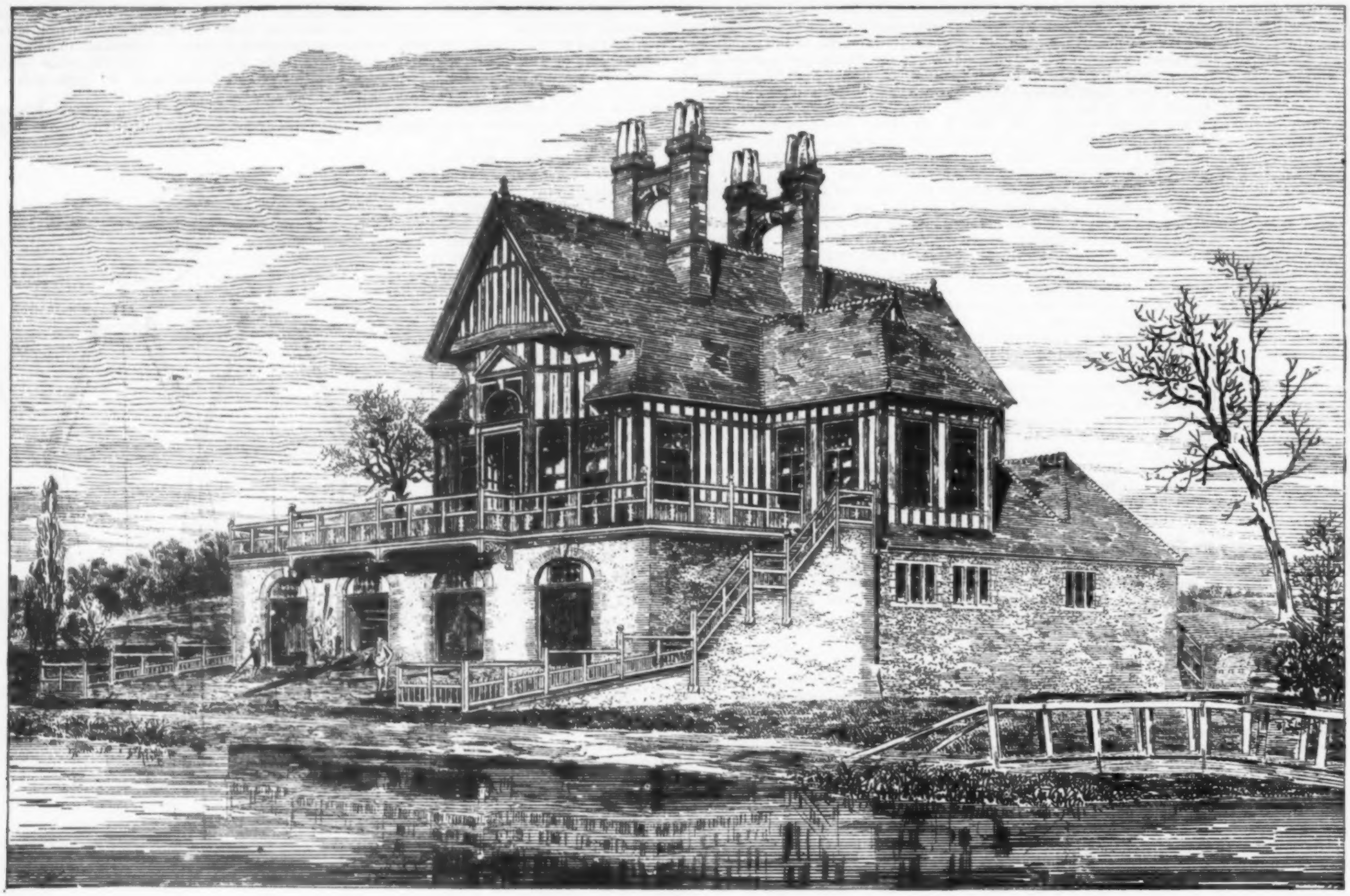
IMPROVED MICROSCOPE.

The two field lenses, A, and the two eye lenses, B, are made of large diameter and of comparatively short focal distances. Their distance from the objective glass, C, is such as to cause a large field of vision. This large size of the field lenses results in forming two separate images at such a distance apart from each other that it is impossible to simultaneously view the object with both eyes. We therefore place the two prisms, D, intermediate of the object lenses and eye lenses and near to the latter. Each prism inclines laterally inward from its end nearest the field lens to its end nearest the eye lens, so that the pencils of light which come from the field lens strike the outer side of the prism and are deflected inwardly against the opposite side of the prism. The pencils of light are then deflected from said inner side of the prism, and are thus brought in line with the eye lens. In this manner the two separate images are brought sufficiently near together to permit the observer to simultaneously use both eyes.

It is obvious that the principle of the improvement is merely illustrated in these microscopes, and that any change, substitution, or omission of parts may be made, provided the essential features of invention hereinafter claimed are employed.

The plate holder, E, is adapted to have sliding movement in frame, F, either independently of or jointly with its slide, G, the latter having screw thread engagement with shaft, H, which permits it to be adjusted to and fro as desired. This plate holder frame is itself provided with a slide, L, and is adapted to be moved in the inclosing frame, M, either independently of or jointly with its slide. A shaft, N, has screw thread engagement with this latter slide.

It is apparent that by taking hold of frame, F, with his hand the observer may quickly adjust the plate holder vertically. If a slower vertical adjustment, however, is desired, it is obtained by operating shaft, N, which moves slide, L, carrying frame, F, up or down in frame, M. If a quick horizontal adjustment of the plate holder is desired the latter may be moved by the hand to any point in frame, F. If, however, a slow horizontal adjustment is desired, by



NEW BOAT HOUSE, OXFORD, FOR THE UNIVERSITY OF OXFORD BOAT CLUB.—JOHN O. SCOTT, ARCHITECT.

operating shaft, H, slide, G, carrying the plate holder, may be correspondingly moved. It is thus apparent that the plate holder may be adjusted vertically and horizontally by both quick and slow movements.

UNIVERSITY COLLEGE BARGE AND BOAT HOUSE, OXFORD.

The barge here illustrated was built for University College, Oxford, about a year ago, by Mr. Saunders, of Streatley, and Mr. Dodd, of Caversham, the former taking the hull, and the latter the house; it cost about £950 in all. The interior consists of a good club room, a dressing room, and other accommodation.

The boat house is now being built for the Oxford University Boat Club by Mr. Silver, of Maidenhead. The lower story consists of the boat house proper, about seventy feet square, giving accommodation for some forty eights and other boats. There is a workshop, etc., behind. Above these are three club rooms, with dressing rooms, bath rooms, etc., and, in the roof, a residence for the keeper. The cost will be about £2,600. The architect in each case was Mr. J. Oldrid Scott.—*Building News.*

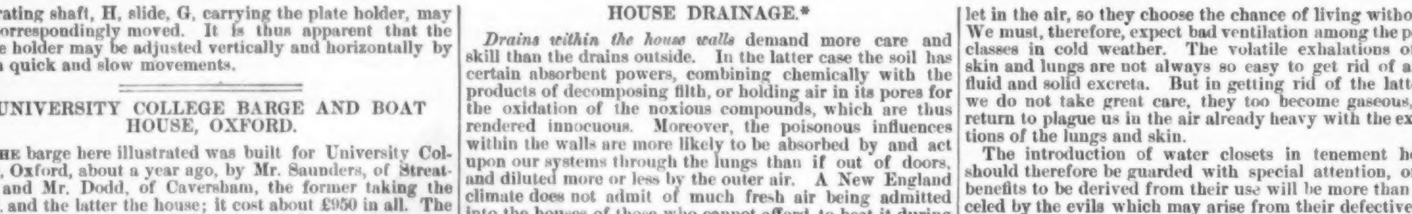
HOUSE DRAINAGE.*

Drains within the house walls demand more care and skill than the drains outside. In the latter case the soil has certain absorbent powers, combining chemically with the products of decomposing filth, or holding air in its pores for the oxidation of the noxious compounds, which are thus rendered innocuous. Moreover, the poisonous influences within the walls are more likely to be absorbed by and act upon our systems through the lungs than if out of doors, and diluted more or less by the outer air. A New England climate does not admit of much fresh air being admitted into the houses of those who cannot afford to heat it during six months of the year. The suffering from frost is immediate, leading the poor man to calk up every crack, while the injury from bad air is a slow poison, warning us only by the sense of smell, a sense which soon becomes benumbed, and rarely becomes sufficiently imperative to lead to action. In fact, its importance is not appreciated by a large part of our population. They might perish with the cold if they let in the air, so they choose the chance of living without it. We must, therefore, expect bad ventilation among the poorer classes in cold weather. The volatile exhalations of the skin and lungs are not always so easy to get rid of as the fluid and solid excreta. But in getting rid of the latter, if we do not take great care, they too become gaseous, and return to plague us in the air already heavy with the exhalations of the lungs and skin.

The introduction of water closets in tenement houses should therefore be guarded with special attention, or the benefits to be derived from their use will be more than canceled by the evils which may arise from their defective construction.

It must be remembered that houses situated on high places, though enjoying the advantage of good opportunity for drainage, may be more exposed than lower sites to the invasion of bad gases from drains and sewers, for the very reason that they are higher, for these gases are light, and are always tending upward. It is well known that the pressure in our gas mains increases very perceptibly as we rise a hill, being about double the ordinary working pressure at an elevation of two hundred and eighty feet above the works, and although the gases in our sewers may not be so light as

* A lecture by Mr. Edward S. Philbrick, C.E., delivered before the students of the Massachusetts Institute of Technology.—*Amer. Architect and Build. News.*



UNIVERSITY COLLEGE STATE BARGE, OXFORD.—JOHN O. SCOTT, ARCHITECT.

illuminating gas,* they are somewhat lighter than ordinary air, and are therefore always tending upward by their buoyancy. This tendency is aggravated during the winter by the rarefied condition of the air within our houses, the ordinary heating of which always creates a slight inward pressure from the outside in all the lower stories.

As a general rule, it is of course advisable to limit the length of the drains within the house walls to a minimum, for the reason that a large number of joints increases the risk of leakage. In planning the lines and course of drains, therefore, this should be kept in view.

In planning the general arrangement of plumbing fixtures, care should always be taken to have them arranged as *compactly* as consistent with convenience, and to avoid scattering them about in remote parts of the house, from which the drain pipes can rarely be collected and combined with a proper fal! to guard against deposits being formed in them. It is also a matter of no small importance to place the drain and waste pipes so they can be readily accessible for inspection and repairs, without tearing up floors. Where located under basement floors, loose trap-doors should be left for access, and if the drain is necessarily below the surface of the ground it should not be buried, but walled in on each side by brick.

The material for drains within the houses should be of metal, in all cases. Stone-ware pipe cannot be trusted on account of their fragile and porous joints, through which gas can penetrate, though they may be impervious to water. For all main drains and soil pipes, cast iron is the best material. It is made in lengths of six feet, with all the necessary special forms for joints, bends, etc. Its joints should be filled with melted lead, and well calked. Right-angled connections must be avoided, except in vertical pipes, for the same reason as has been given for outside drains. Oblique connections can always be provided for by arranging the lines of pipe for the purpose, if care be taken. Vertical lines of drain from water closets, generally called soil pipes, were formerly made of lead, and this material is still used in England. But iron has taken its place in this country for several years, with success. It has these advantages: Its rigid nature renders it less likely to get out of place than lead, which often sags and changes form. Lead is also more subject to corrosion from the gases existing in drains than cast iron. Wrought iron would rust away rapidly, but cast iron rusts only on the surface, and seems capable of enduring for twenty years or more, while lead is often found badly corroded in ten years. The corrosion in lead takes place along the joints where in contact with the solder, probably from galvanic action, excited by the contact of the two metals. Lead is often exposed to damage, as is shown by these samples before us, taken from houses in this city, also from rats, which gnaw holes in it, and nails carelessly driven in securing the woodwork have often made holes that were not discovered for several years. The joints of iron pipe are sometimes put together with putty by poor workmen, but it can never be relied upon for any length of time. It soon crumbles away and becomes worthless. The lead should be applied nearly or quite at a red heat, so as to penetrate the thinnest parts of a joint without becoming chilled. When cooling, it contracts so much that it must be upset with calking tools, applied around the whole circumference.

The small waste pipes from bath tubs, bowls, sinks, etc., are generally made of lead, which is a very suitable material. Where entering the iron pipes, the joint is often made by applying hydraulic cement, putty, or red lead. But the proper way is to solder a brass ferrule to the lead pipe, which is inserted into the bell of the iron pipe. This gives a stiff material, against which a lead joint can be calked, in the same way as between two pieces of iron pipe. When lead traps are used under water closets, the joint between these and the iron soil pipes should be secured in the same way.

Every vertical line or "stack" of soil pipe should extend through the roof of the house at least four inches in diameter, and far enough above the roof to insure its end from being filled with snow. The end should be left wide open. If a smaller pipe than one four inches in diameter be used, the part projecting above the house roof will be liable to be filled with hoar frost on cold nights in our climate. With this arrangement a constant draught is maintained through the house drains, entering at the vent hole close to the outer trap, and passing up through the roof of the house. The temperature of the house in winter is always enough above that of the outer air to sustain this draught. In summer the sunshine on the upper end of the pipe will encourage it, for the hole at the lower end is below the surface, where the ground cools the air and thus renders it slightly more dense. This upward draught is reversed for a moment whenever a considerable charge of water is emptied into the drains from the upper stories of the house, for the water pushes the air down as it falls, and other air takes its place from the upper end of the pipe. If both of these holes are not kept open, trouble will be sure to follow the use of the drains, for the water rushes down the vertical pipes with considerable velocity, and if it nearly fills the pipe, it acts like a piston, to drive all the air in advance. If the free escape of this air were not provided for by the vent hole at the bottom, the air within the pipe would be forced out at any or all the branch drain pipes in the lower story, forcing their traps and blowing their contents up through the waste holes in a very disagreeable manner. The puff of air that is thus driven out of the house drain at its lower vent hole by a descending charge of water from the upper stories, has sometimes been objected to on the ground of a possible offense arising from it at the mouth of the man hole over the trap previously described, but this is not found to exist in practice. The air from a well ventilated drain is not so foul as to pollute the air outside the house to any great extent, though when allowed to escape and taint the air *within* the walls, where the dilution is very much less, the result is much more serious.

Moreover, as before explained, the escape of air at this lower vent is only by occasional puffs forced out by descending charges of water, while at all other times the draught is inward at the lower vent hole. So that this very air which may have been forced out for a moment into the man hole chamber, is again drawn up through the pipe and delivered at the top of the house above the roof, before it has an opportunity to escape from the top of the man hole itself. Practically, no reason appears to exist why these vents should not be placed near the house, outside, in either the front yards, on the sidewalk, or in the back yard, as the case may be. If the man hole cover is liable to be covered with snow for any depth, an air pipe of four or five inches diameter should be led up from beneath the cover, to terminate a few feet above the ground, at the top of a back yard fence, or similar position.

The arrangement described above is essential to every house. By this means every part of the main drain is not only kept in accord with the normal atmospheric pressure, but is also swept by a constant current of air. If there be more than one stack or vertical line of soil pipes, each one should extend through the roof separately.

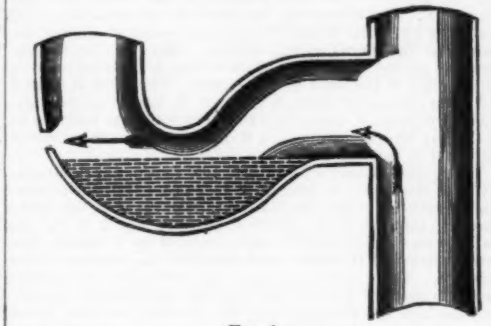


FIG. 9.

Smaller branch waste pipes leading from bowls, bath tubs, sinks, etc., can all connect or discharge into the soil pipe or main drain where most convenient, but each branch should also have a vent to the open air, and a separate trap under each sink, or bowl. Without such ventilation for each branch, the discharge of a few gallons of water through any of them will be likely to empty any or all the traps that connect with it, by siphon action. Moreover, the discharge of water down the vertical stack itself will often produce this effect, by the friction between the descending water and the air in the branch pipe at the junction. It is always best to lead the waste from each bowl or tub *separately* to the soil pipe or drain. If these branches connect with one another before joining the soil pipe, the drainage through one is very likely to disturb the air in the other, and thereby destroy the seal in their traps. It has been a common practice among plumbers in this country to lead the waste water from bath tubs, bowls, etc., into the trap of the nearest water closet, below the water line; but such a practice is never advisable, for several reasons. The discharge of warm water into this large trap heats up its contents, which are generally composed in part of fecal matter, and the steam and odors arising therefrom are very likely, by their expansion when so heated, to find some crack by which they can penetrate into the rooms. Moreover, a slight sagging of one of the pipes or a tipping of the trap itself, which sometimes occurs in time, will throw the connection above the water line and destroy the seal. Another defect in this method of connecting wastes of bowls to water closet traps arises from the length of waste under the floor which has so little fall that the trap water holds the water back in it for several feet, where it has ample time to make noxious deposits. (See Fig. 10.)

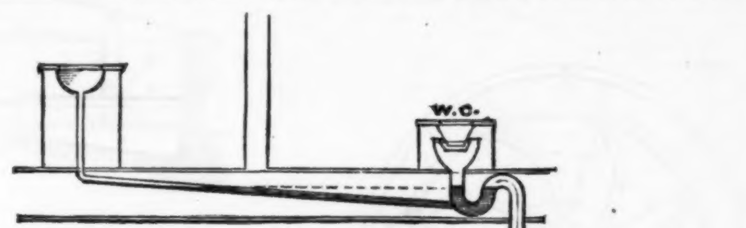


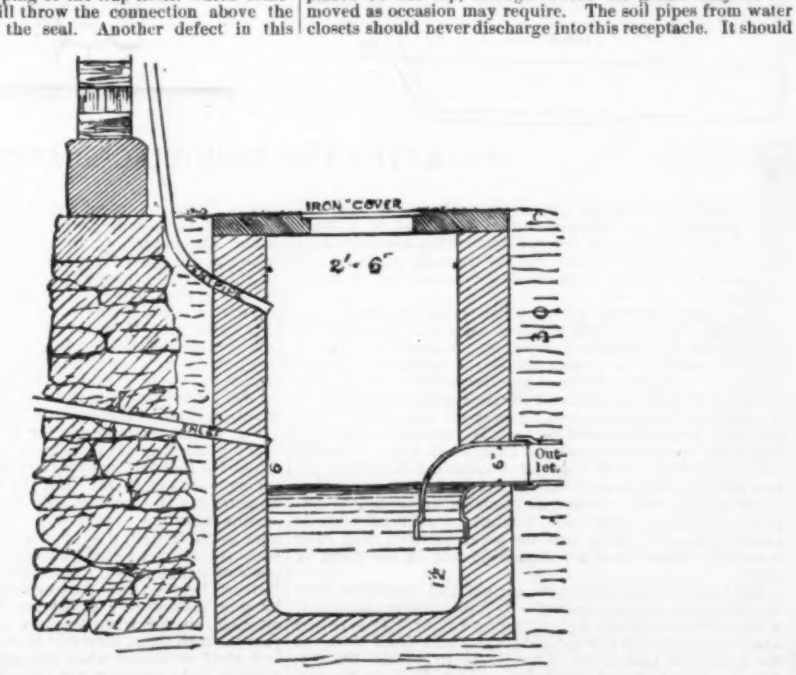
FIG. 10.

It is usual to provide a small tank or cistern in the upper part of a house, from which water can be drawn, when wanted, more rapidly than from the small pipe which supplies the house from the street. Such a tank is fed by a faucet governed by a float, so that it is kept nearly full. As any defect in the action of the float might cause the tank to overflow, it must always be provided with an overflow pipe to carry off the water in such an emergency. If this overflow pipe is connected to a waste or drain pipe, the foul air will rise through it and escape through its open mouth at the top, where it may taint the water by being absorbed by it, or taint the air about it. No trap placed upon such an overflow can be relied upon, for the flow occurs so seldom that such a trap would lose its water by evaporation and soon become worthless. The safer way is to discharge such overflow pipes in the open air, either outside the house, in a rain spout, or on the roof. If this cannot be conveniently arranged, they should be allowed to discharge over an open sink or bath tub, or similar receptacle, without direct connection with the drains.

Where no public water supply exists, large tanks for storage of rain water are sometimes constructed as a source for domestic supply, located under the ground, with overflows discharging into the main drain. Such a course should never be allowed. No intervening trap can serve for stopping the back flow of gas, because the overflow does not occur often enough in dry weather to insure the presence of water in such traps. Such overflows ought to be discharged on to the surface of the ground, or in a pit filled with loose stones in a porous soil, where the water will readily soak away at all times.

An instance occurred within my own observation a few years ago, where the overflow of a rain water tank discharged into the main drain. This became choked with grease, and set back all the sewage of the house into the cistern, through the overflow. The water was used for all domestic purposes, and its pollution was discovered only through the nauseous taste it had acquired after some weeks' accumulation of sewage in the cistern. This leads us to the question of grease in drains, a prolific source of annoyance in our climate. The grease comes from the washing of dishes in kitchen sinks, which goes down the wastes mixed with warm water in a fluid state. It soon becomes chilled in cool weather, and adheres to the sides of the drain, where it accumulates continually, till sometimes filling the pipes for long distances. If the drain has a very rapid descent, the flow of water may sometimes prevent this accumulation, but otherwise some provision is needed for intercepting the grease in a small tank. The nearer this tank is to the sink the better, to guard against the choking of the pipe above the tank.

Where the sinks are located against the outer wall of the house, the tank is best placed outside the walls, where the grease can be removed without creating a nuisance in the house. Such a tank is shown in section below, built of brick and hydraulic cement, plastered smoothly inside. For small and medium houses it should be at least three feet long on the inside, and about two feet wide, with rounded corners. The outlet should be made of a bent joint of pipe dipping under the water, so that the grease, while floating on the surface, will not be drawn into it. The inlet should be at least six inches higher than the outlet, so as not to be obstructed by the accumulation of grease which takes place in the form of a thick scum on the water. It is also best to allow about a foot below the mouth of the outlet in the clear, for the accumulation of sand and other solid matter, which is heavier than the water. A man hole cover is placed on the top, through which the grease may be removed as occasion may require. The soil pipes from water closets should never discharge into this receptacle. It should be arranged upon the branch leading from the kitchen and pantry sinks only, having its outlet connected with the main drain when convenient.



If the sink is not situated near enough to the outside of the house to allow this grease tank to be constructed outside the walls, it can be made in the cellar or basement, of wood, and lined with heavy lead. In such cases, the grease does not cool so readily as on the outside, and if the tank is not of a liberal size, the grease is liable to pass through before being separated from the water. Whenever drains become choked with grease, if the pipe is accessible, it can be cleared by pouring hot water over the outside in a small stream, for half an hour or less. This heats up the whole contents,

* Ordinary illuminating gas has a specific gravity of 0·42, that of air being 1·00. The increase of pressure in gas pipes as they extend up to a higher level is due to the difference in weight between the air and gas for the height traversed; gas when distributed from the works is under a pressure of about 2½ inches of water.

The weight of a cubic foot of water is 62·4 lb.
" " " " of air is 0·08 "
" " " " of gas is 0·0336 "

Difference between air and gas equals 0·0464 lb. per cubic foot.

We have then the following proportion:

0·0464 : 62·4 : : 1 : 1,335 inches, or 111 feet elevation for one additional inch of water pressure.

and the softened grease then passes along with the water that is applied inside. But the better way is to catch the grease before it gets into the pipes. If once allowed to coat the inner walls of the drains, much trouble will ensue.

I have before alluded to the need of getting the plumbing fixtures inside the house arranged as far as possible in compact groups. It is a very common fault among architects to so arrange them that their drain pipes are led across considerable lengths of floor spaces, with little or no fall, terminating, as before described, in a water closet trap, just below the floor, which sometimes holds the water for several feet back in this horizontal reach of pipe. Whenever a bowlful of water is discharged into such a flat waste, the lower end of which is filled with water, the air that happens to be in the pipe above such water is displaced and is driven out. Where can it escape? Sometimes it finds a branch waste coming in from another apartment, and is blown up that, through the trap and waste hole of a wash bowl in a sleeping room or dressing room attached. Sometimes it bubbles up in one's face in the bowl that is discharged. Sometimes it is pushed forward and bubbles up in the water closet. The result in either case is far from satisfactory, and shows how important it is to give each line of waste an independent and unobstructed course to the main drain or soil pipe, where the air can find ready communication with the outer air.

APPARATUS FOR CLEARING SEWAGE.

In the accompanying engraving we illustrate an ingenious apparatus for clearing sewage of the grease and flocculent matter which cause so much trouble to our sewage irrigated grass farms. Sewage farming under our modern sanitary laws has become of so much importance that any arrangements which tend to lessen the cost to ratepayers and danger to the health of the public cannot fail to be considered with great interest. Our illustrations show some new arrangements that have been designed by Messrs. Parrot and Good, of Croydon. The mud, grease, and flocculent matter, as they are now carried on to the farm, are not only injurious to the land by making the subsoil impervious, but they kill large patches of rye grass almost at once, and in a short time destroy the crops of whole fields. Thus not only is a great loss of produce caused, but the capacity of the farm to purify the liquid portion of the sewage is seriously reduced.

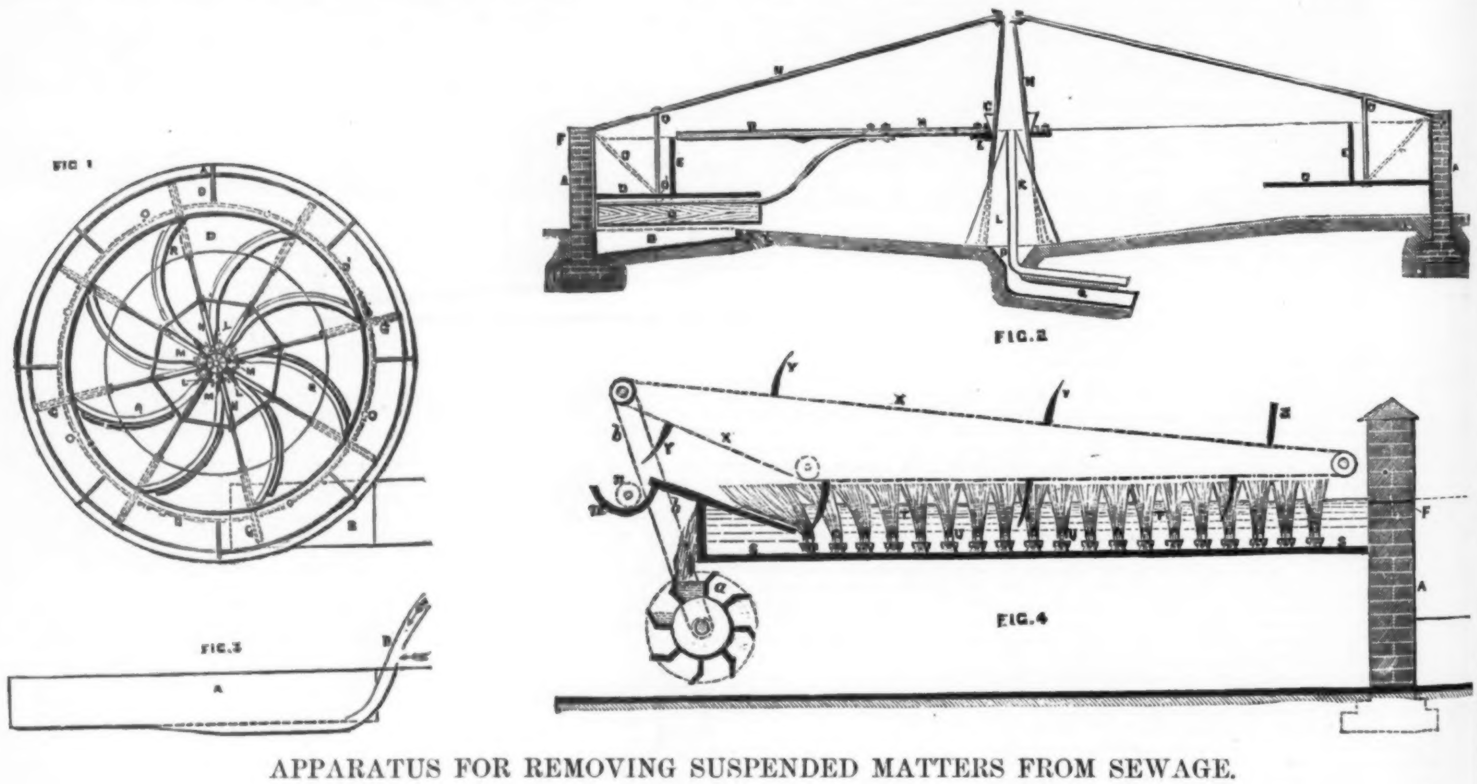


FIG. 1 FIG. 2 FIG. 3 FIG. 4

APPARATUS FOR REMOVING SUSPENDED MATTERS FROM SEWAGE.

Fig. 1 shows the way in which the mud and grease are dealt with. The processes, however, are distinct, as the mud is collected by artificially applying a natural law, which causes it to fall at the bottom and in the center of a tank, whence it is drawn off by a pipe from below; while the grease, as it floats, is skimmed off the top and conducted to a funnel and pipe in the center just at the water level. A is the outer circumference of the tank, B is the culvert through which the sewage flows into the tank, a side view of which is shown in Fig. 3 at B. By thus conducting the sewage into a circular tank at an elevation of 1 ft. to 3 ft. according to the quality of the sewage, and causing the stream to impinge on the side of the tank, a whirl or artificial eddy is caused, the result being that the solid particles find their way to the center and are then deposited in the form of mud.

But to make this result more certain and complete there are some internal arrangements. D is an annular plate about a foot from the bottom and extending 4 ft. or 5 ft. into the tank, to prevent the sewage and its contents from rising at the side of the tank before it has begun to whirl. On this annular plate is placed a cylinder or ring, E E, in the section, Fig. 2. The object of this cylinder is twofold: First, to confine the foam containing the grease within the reach of the revolving skimmers—to be described below; and secondly, to allow the clarified sewage to escape from the tank in the thinnest possible trickling steam. Thus, while the sewage enters the tank 4 ft. in width and 6 in. in depth, or 9 in. in depth on one side of the culvert and 3 in. on the other, as shown at B, Fig. 2, the outflow of the sewage will spread over a space of 72 ft.; that is, taking a tank of 30 ft. in diameter, and the cylinder standing 3 ft. from the outer circumference, it will give 72 ft. for the sewage to escape over it.

This arrangement was designed so that the sewage might escape in a circular form and over the greatest possible extent of surface, that there might be no strong cross current to carry away the foam and the coarse flocculent matters. The sewage having thus fallen over the cylinder, it finds its way in the gutter between the cylinder, E, and the outer wall, A, to the final overfall, as far as the tank goes, at F in the section, Fig. 3. The stanchions, N, are for taking the central bearing of the rods, N N, and the guy rods, O O, for aiding in holding the annular plate and the cylinder it bears in a rigid position. They at the same time act as guides for keeping the revolving skimmers in position, and as they are placed obliquely at the bottom they aid in securing the deposit of the mud exactly in the center over the funnel, P. C C are merely brackets on the stanchions for carrying a circular bridge for a man to stand on should the mud over the funnel require stirring. Between the stanchions are placed eight plates of sheet iron, L L, to fully secure the deposit of the mud in the center. The mud is drawn off from the funnel through the pipe, A, and it may be delivered of a thick consistency that will just clear itself, or in a thinner form according as a slide in a square mouthpiece is raised or depressed.

The grease is dealt with by means of the curved skimmers, R R, as shown on the plan, Fig. 1. To cause these to revolve the stream under the annular plate is utilized by its being made to impinge on the paddles shown in Fig. 2 at G. As will be seen these paddles are connected by a curved iron arm to arms, H H, which are floating on the surface of the sewage. These arms are made of wood, and the paddles are also made of wood of the required thickness, to counteract the high specific gravity of the curved iron bars which connect them. As will be seen by traced lines in the center of Fig. 1, and in section in Fig. 2, there is a flat iron ring around the stanchions. To this ring the wooden arms, H H, —eight in number—are bolted. To the wooden arms the curved skimmers are made fast. Thus the paddles, G, the arms, H, and the skimmers, R, are rigidly tied together, and they must therefore all revolve simultaneously and at the same rate. This appears to be an important point. For as the sewage travels rapidly under the annular plate, and the current decreases more and more toward the center, the skimmers necessarily travel faster than the surface they skim. The natural result of this is, as the backs of the skimmers are above the water level, a sufficient current in the skimmers is produced to carry the floating foam toward the center, and when it gets within the ring it will be naturally drawn into a funnel to be fixed just below the water level on the pipe, K, whence it will be conveyed to a receptacle outside the tank. There the water with it will be further reduced by a self-acting tank, when it will be warmed enough to fuse it, so that it will draw off as recovered fat. As this fat is worth 28s. per cwt. retail for lubricating cart wheels, a considerable profit is expected.

Fig. 4 is an arrangement for recovering the finer pulped paper which is found in large quantities in sewage. It is contended that this pulp may be washed and remade into common sorts of paper. But the immediate object of the arrangement is to prevent this finer flocculent matter from passing with the sewage water to the rye grass. This is done in the trough, S S, by placing in it what have been aptly termed "inverted brushes and brooms." These are made of Italian whisk, French dog grass, and Esparto grass, fastened between two narrow strips of wood, and they are hung on the end of a projecting iron rod with a pendulum attached, so that when they are resting for the sewage to pass through them they will be in a perpendicular position, and yield or deflect when the combs and scrubbers pass through and over them for cleansing them of the clots of felt they will gather together. The two latter lengths of fiber are made of bass—*pias sava*—grown in South America, and they are about two feet in length, that the floating clots of felt may be conducted on to the apron as they are liberated by the teeth of the combs or rakes, and be then swept into the trough, M, by the India-rubber scrubbers; U U in the section are the boards, iron rod, or plate and pendulum which hold and regulate the rows of fibers; T T are sections of the fibers. The endless chains, X X, which carry the combs, Y Y, and the scrubber, Z, need no description, as their mechanical details are obvious. The water, as is also obvious, flows from the tank at F, and leaves the trough at *b*, where it falls on to a small over-shot wheel which gives ample power for driving alternately the endless chain carrying the combs, and the Archimedean screw, *n*, for emptying the trough, *m*. There are some other suitable mechanical details for producing the required alternate or intermittent action referred to, but these need not be described. It may be said, however, that the patentees contend that if, in addition to using the tank, bristles and horsehair be fixed in the trough instead of or in addition to the fibers mentioned, the fine weeds which are now so much trouble and expense in the sand filtering beds of water companies which draw their water from open rivers, nearly the whole of the organic matters—coarse and fine—may be intercepted before the water is passed to the sand beds for final filtration. If this be so, these arrangements will save the water companies a large cost in sand and manual labor.—*The Engineer.*

SILVER PLATE EXHIBITION, AMSTERDAM.

This is the most interesting loan exhibition which has ever been held in Holland, and the efforts of the club of Dutch artists to make it complete have been crowned with success. Ecclesiastics, both Protestant and Roman Catholic, have for the time denuded the "treasuries" of their respective churches in order to aid a national work in which all were concerned, and whatever they possessed that was precious, in books, missals, church furniture, and the like, was placed freely at the disposal of the club.

Nor has the hearty assistance of other countries been wanting. Sir Philip Cunliffe Owen, of the South Kensington Museum, has sent a large case of electrotyped shields, vases, cups, caskets, spoons, plaques, etc., which form by no means the least imposing group in the exhibition; and Professor Lessing has sent a kindred collection of electrotypes from the Gewerbe Museum in Berlin. Prince Frederick of the Netherlands and the Duke of Saxe-Coburg-Gotha are also distinguished by the value of their contributions. A small volume in the bookbinding section, lent by the latter, is peculiarly precious. It is only about two inches square; but its tiny covers are rarely enameled with figures and literally incrusted with diamonds, rubies, and emeralds. The volume is valued by experts at a hundred thousand guilders, which in British money would be equivalent to eight thousand three hundred and thirty-three pounds sterling—a rather remarkable price for a volume which lies easily within the palm of a lady's hand.

But by far the most numerous and, perhaps, most characteristic contributions come from churches, town corporations, and private individuals. Among the last is Dr. J. P. Six, a descendant, we believe, of the Burgomaster Six of Rembrandtish renown. The memory of the connection of the two names he is careful to keep green by maintaining intact the finest private collection known of the works of the great master of chiaroscuro. With the aid of other contributors, he has furnished a dinner table just as it would have been set forth a hundred years ago. The soup tureens are of silver, and the plates of Nankin blue of the Lange Lijsen pattern, so much prized in London during the last few years. At the side of each plate lie a blue delft-handled knife, a fork, and a spoon; and the look of the appointments is at once rich and quaint.

One curious collection of objects was to be found in children's toys and playthings, all of which, it would appear, were, two or three generations ago, made of silver. The articles represented were such familiar objects as boats and sails, sledges, horses, goats, coaches, barrows, spinning-wheels, rope-dancers, boys and hoops, tea-things, chairs and tables, and, of course, windmills and milk-maids. They were all of miniature size, and such as a lady of our own time might almost wear among the nick-nacks attached to her girdle.

Another very characteristic portion of the collection consisted of a set of silver-mounted whips of a portentous size, with great knobbed handles, looking just like the staves of state carried by English beadles on high parish occasions, only the bulbed end was the handle end, and to the other was attached a lusty whip-thong. Such whips used to be given, particularly in Friesland, as prizes to the winners of trotting matches, on which occasions the trotter was harnessed to a high, old-fashioned chaise, and so driven. During the present century, however, winners have preferred for their prizes silver teapots or teakettles, tobacco-pots, and

often money, and the grand whip is known only now but in museums.

We do not know whether the arrangement of the catalogue is in harmony with Dutch tradition; but we were rather struck with the circumstance that drinking vessels take precedence of everything else in the museum, and with the variety of names under which such vessels are classified. There are, for example, five different kinds of *Bekers*, then come *Drinkhoorns*, Drinkschalen, Drinkkroegen, Koppen, and Drinkkannen. These are followed by other objects pertaining to the table and by various miscellaneous articles, including coins, medals, badges, armorial shields, watches, seals, and trinkets of all kinds. Then comes a section devoted to bookbinding, so far as it embraces the goldsmith's and jeweler's art; and, lastly of all, there are most valuable contributions from the three great religious bodies living in Holland—viz., the Jews, the Roman Catholics, and the Protestants, and it is in this order that they are placed in the catalogue.

The collection consists of 854 exhibits, and from what we have said our readers will rightly conclude that it is of rare variety and excellence. In point of time, the examples begin about the middle of the sixteenth century and come down to pretty nearly the close of the eighteenth. There seems, moreover, no style, from the matchless modeling and designs of Benvenuto Cellini to the filigree work of the Genoese, which Dutch goldsmiths and silversmiths have not imitated and often rivaled. We were particularly struck with the workmanship of a golden cup by Paulus Van Vianen, dated 1610; with another by an artist *onbekend*, on which three exquisitely designed figures in colored enamel of Judith, Deborah, and Jael fill each a separate compartment; and especially with a ewer and dish by Adam Van Vianen, dated 1614. In the bottom of the dish were represented in low relief a charging squadron, cannon in batteries, and spearmen ranked in squares, all with a force and truth which produced on the eye quite a pleasant pictorial effect. There is also a very fine dish, twenty-two inches in diameter, filled with classic subjects treated in a manner worthy of the best period of the Renaissance; and yet it and the accompanying vase date no farther back than 1712. Indeed, there are several choice examples of repoussé work in the Exhibition, and of ivory jugs in high relief not a few; but enough has been said to indicate the character of the Exhibition, and we will conclude our notice with a word or two on the spirited club, whose motto is *Arti et Amicitiæ*, and on the club house in which this fine collection of gold and silver work is being exhibited.

The building, a substantial erection with some architectural pretensions of a modest kind, is about the size of one of our smaller club houses, and stands in the Rokin-straat, facing the canal of that name, so called, some fancy, because in olden times women used to be drowned here for witchcraft; and *rok* they say is Dutch for petticoat. This building, along with a good many others in the same locality, is the property of the club, which exists that it may promote art, succor the widows and orphans of their late members, and encourage brotherhood among the living. It was started about forty years ago by a few enthusiastic artists—by which our readers will understand those belonging to the plastic arts—whose pockets were anything but plethoric; and now they number a thousand members, more than the half of whom are private gentlemen, possess many capital buildings of their own, and 150,000 gulden invested in the four-per-cents. The catalogue, which is in Dutch, is in the fullest manner descriptive; and its compilers have introduced one feature which strikes us as worthy of imitation. To the number of the century to which an article belongs is invariably added one or other of the first four letters of the alphabet to indicate the time more precisely—"a" meaning the first quarter of the century, "b" the second, and so on. Definiteness of this kind, as to date, is of great value to the archæologist.—*J. F. R., in Illustrated London News.*

THE GIANT OF THE CATSKILLS.

A CORRESPONDENT of the New York *Sun* calls attention to a remarkable recumbent figure of a man of gigantic proportions, shown in the sky-line of the Catskill Mountains, as looked at from the Hudson. He says:

I have noticed this figure when traveling both by boat and by rail, and have pointed it out to others, who never failed to be immediately impressed by its striking resemblance to the human form. The figure is formed by the peculiar juxtaposition of a number of peaks, situated over the southeastern corner of the Catskill group, below Round Top. The profile of the face begins to unfold when the train or boat is just below Tivoli, and after passing that place the traveler sees the whole figure of the giant from the head to the knees. He lies on his back, with his feet sloping toward the river, his head pointing a little west of north, and his face turned up to the summer sky.

Much allowance must, of course, be made for the effects of the imagination, which is most active in such scenes, but there has always seemed to me to be an appearance of majesty as well as a look of kindliness in the giant's face. The features are remarkably clear cut. The smooth, rounded brow is interrupted near the junction with the nose by a slight ridge that strikingly represents the eyebrow. The nose is long and well formed, and its outline as well as that of the chin makes the face appear to be turned slightly away from the observer and toward the southwest. The appearance of repose at once impresses the observer. The giant seems to have lain down under the sky for a long sleep. One might fancy him to be the genius of the Hudson, wearied by some Herculean labor, such as breaking a way for the river through the Highlands just below. His arms, folded across his breast, are represented by a mountain with an elongated summit, and the bend of his knees is marked by another mountain.

The best view of the figure, as a whole, is obtained between Tivoli and Germantown. After the traveler has passed Germantown the outline of the breast and knees is so much foreshortened that their likeness is injured, but the face becomes rather better. Near Hudson a deep furrow comes into the brow, which greatly changes the aspect of the face, giving it a somewhat forbidding look. As the train speeds northward from this point the figure of the giant slowly sinks in the horizon, the rocky face longest retaining the human likeness, until finally near Coxsackie that, too, disappears behind a nearer range.

INVESTIGATION shows that the blood of the Bengalee contains far fewer red corpuscles than that of the European. The difference in question is believed to be due chiefly, if not wholly, to the circumstances in which the lot of each has been cast, since the inhabitants of swamps and jungles are supposed to be necessarily of lower organization than those of breezy and well cultivated uplands.

EXPLOSIVE MIXTURES OF COAL GAS AND AIR.

By Mr. W. FOSTER, M.A., Etc., Professor of Chemistry at the Middlesex Hospital.

THE disastrous events which have recently occurred through the ignition of explosive mixtures of coal gas and air have excited a considerable amount of attention, and have given rise to much unnecessary anxiety. As an abstract proposition, the dangerous nature of a mixture of coal gas and air is generally understood not only by those engaged in the manufacture and distribution of gas, but also by a large section of the educated public. The best practical method of dealing with such mixtures and of preventing their formation is, however, a matter on which much misconception exists; and this chiefly arises from an insufficient appreciation of the general properties of gaseous bodies. A knowledge of the practical bearing of the laws of the diffusion of gases is not by any means so general as one could wish. The present, therefore, appears a fitting occasion for a few observations on a subject of the greatest importance to all concerned in the manufacture and use of coal gas. It may appear an idle statement to say that coal gas, in a confined vessel, is perfectly harmless; but unfortunately one is continually meeting with persons in all grades of society who do not share such a simple opinion. It, therefore, often becomes a part of the gas manager's duty to instruct his customers with reference to the properties of the article he manufactures.

Coal gas, whether cannel or common, is a mixture of several gases with the vapors of hydrocarbons of low boiling point. By far the greater portion of any given volume of common gas consists of hydrogen and marsh gas (CH_4), the sum total of these two components varying from 80 to 90 per cent. of the whole. In 1851, Dr. Frankland made an analysis of the common gas supplied by the Chartered Gas Company in London, and in 1876 the same company's common gas was analyzed by Mr. Humpidge. The results of these two analyses, so far as the chief components are concerned, are given in the following table:

	1851.	1876.
Hydrogen	51·8	50·5
Marsh gas (CH_4)	35·2	38·3
Carbonic oxide (CO)	8·9	3·1
Heavy hydrocarbons expressed in their equivalents of olefiant gas (C_2H_4)	7·7	7·8

Now each of these components, when allowed to escape from a containing vessel into the external atmosphere, can be ignited and consumed like any other combustible material. The oxygen of the external air is necessary to carry on the chemical action which is commenced by the application of the ignited substance; and, in the case of the gases containing carbon, further provision is necessary for the removal of the carbonic acid gas produced. The high temperature required to start the combustion of the gas is maintained by the chemical combination of the latter with oxygen.

Coal gas does not differ in these points from its individual components. For its ignition the heated body must have a temperature of a certain quality—a circumstance quite apart from the total amount of heat which it may possess. The smallest spark of brightly incandescent matter, whether solid or gaseous, is sufficient to inflame a jet of coal gas escaping in atmospheric air. An excellent illustration of this phenomenon is afforded by the use of the electric spark. If a person insulate himself from the earth by standing on a stool having glass legs, or on a couple of glazed earthenware jars, and while in this condition place his hand on the conductor of an electrical machine, sparks may be taken from his body during the time the machine is put in motion by a second individual. If a jet of coal gas be allowed to escape from a metallic burner within his reach, on his extending his other hand and causing one of his fingers to approach the burner from above, a spark will at length pass to the burner, producing ignition of the gas.

[It will be remembered that this principle was advocated on a limited scale a few years ago, when there was a prospect of a tax being imposed on lucifer matches. The apparatus was ingenious, but cumbrous.]

In this experiment the particles of gas in the track of the spark are rendered brightly incandescent; and although their mass must be extremely small, yet they are capable of setting up a similar condition throughout the whole gas jet. On the other hand, comparatively large masses of solids at lower temperatures are incapable of setting up a similar condition of things. For instance, a coal cinder at a dull red heat and devoid of flame will not cause ignition of a jet of coal gas, neither will the dull red embers of a recently extinguished deal wood match. It is clearly obvious, therefore, that heat as a quantity is not essential to the commencement of the phenomenon of ignition. The substance, whether solid or gaseous, must possess those qualities which enable it to emit light radiations of a certain order—those which are particularly abundant at the more refrangible end of the spectrum produced by a source of white light.

If the composition of a sample of coal gas be given, the amount of oxygen (and therefore of atmospheric air) required to effect its perfect combustion is a matter of simple calculation. Let us consider the case afforded us by Dr. Frankland's analysis. As every two volumes of hydrogen require one volume of oxygen, the 51·8 volumes of hydrogen given in the analysis require 25·9 of oxygen. Every two volumes of marsh gas require four volumes of oxygen, and therefore 31·5 would require 63·0. Every two volumes of carbonic oxide require one of oxygen, and therefore 8·9 requires 4·4. Every two volumes of olefiant gas require six of oxygen, and therefore 7·7 require 23·1. The results of these four independent oxidations are expressed in chemical symbols, as follows:

$$
\begin{aligned}
H_2 &+ O = H_2O \\
CH_4 &+ 2O_2 = 2H_2O + CO_2 \\
CO &+ O = CO_2 \\
C_2H_4 &+ 3O_2 = 2H_2O + 2CO_2
\end{aligned}
$$

On adding together these several quantities of oxygen, we find that 100 volumes of such common gas require 116·4 volumes of oxygen for their complete combustion. As every five volumes of air contain one of oxygen, it follows that the quantity of atmospheric air necessary to completely effect a like result is 582 volumes. In other words, one volume of gas of the quality under consideration requires nearly 6 volumes of air (5·8). I need hardly say that, in practice, larger volumes of air are necessary to carry on the ordinary process of combustion in an efficient manner, the surplus air assisting very materially in removing the products of oxidation from the points where they are produced.

When atmospheric air is mixed with coal gas in the proportion of about 2½ volumes of the former to 1 of the latter, the mixture can be ignited when issuing from an ordinary burner, and consumed in the same way as the undiluted coal gas. The character of the flame, however, differs from that produced by the pure coal gas in that it loses, in a very marked degree, its light-giving properties. This phenomenon has given rise to much experiment, and is the result of several influences operating somewhat differently. Their consideration is outside our present question. In the case of a mixture having the proportions I have just named, it is obvious that a considerable proportion of oxygen is required for the complete combustion of the gas. This additional quantity is derived from the external air, as in ordinary cases. If we take a mixture of gas and air in the proportions needed for the complete combustion of the gas (and in the case of the particular quality we have already considered, we shall require 6 of air to 1 of gas), such a mixture can be burnt under special circumstances, and is, *theoretically*, quite independent of any supply of oxygen from external sources. Such a mixture is explosive. Suppose, for instance, that a cubic foot of it be confined in a spherical vessel, and that a flame be applied to a portion of the gaseous mass, rapid combustion of the mixture would immediately follow with explosive violence. As it contains in its own substance the oxygen required to form the ultimate oxidation products, and as these are gaseous and produced at an excessively high temperature in a very short interval of time, the pressure which they exert on the sides of the containing vessel is very great.

One speaks in general terms of such an explosion as being instantaneous. Such, however, is not absolutely the case. A certain definite interval is needed for the completion of the action commenced by the application of the lighted substance. In other words, the flame applied to the explosive mixture traverses its substance with a certain velocity. The proportion of gas and air now considered are those which we have deduced from the analysis. In practice, however, where explosive mixtures are needed, as in the modern gas engines, a larger proportion of air is required to yield the maximum explosive force, and in the case of ordinary common gas about 1 volume to 8 volumes of air furnishes the best results. We will consider the behavior of mixtures of gas and air in varying proportions subsequently. Let us for the present confine our attention to the behavior of a cubic foot of an explosive mixture when ignited in vessels of the same capacity but of different shapes.

I have selected a spherical vessel as the starting point in our discussion, because it is symmetrical. When filled with an explosive mixture and fired, there is a greater pressure on each unit of area of surface than in any other vessel of the same capacity, because a less interval of time is necessary for the passage of the flame to every portion of the explosive mass. In order to realize the velocity of the passage of the flame through the explosive mixture, we must alter the shape of the containing vessel. A cylinder is the best adapted for our purpose. A cylinder a yard long and 8 inches in diameter would have a cubical capacity of one foot, and when filled with the explosive mixture and fired at one end would not produce such a very marked effect as in the former case. A tube 2 inches in diameter would require to be about 16 yards long, and if filled with the explosive mixture and fired at one end as before, we should be able to distinctly realize the interval required for the passage of the flame from one end of the tube to the other. The explosive action would also be very considerably diminished. If we now take a tube having a diameter of half an inch it would require to be 256 yards in length in order to have a capacity of one cubic foot, and if we were to take any convenient length of such a tube made of glass and fill it with the explosive mixture, on igniting it at one end we should observe that the flame would pass down the tube without giving rise to any explosive action, and at such a rate as to admit of its velocity being measured. There are two important influences tending to bring about this modification of the result. First, but a small quantity of the explosive mixture is consumed in a short interval of time; and, secondly, there is the cooling effect of the sides of the tube on the gaseous products of combustion. Their temperature is never so high as when produced in larger masses, because the cooling action of the sides of a cylinder is greater in proportion to its diminished diameter. This is easily shown by the following considerations:

Taking the ratio of the circumference of a circle to its diameter as 3 (this has been done in former calculations), our first cylinder, namely, that having a length of 36 inches and a diameter of 8 inches—gives 24×36 or 864 square inches as the area of its containing sides. In the last case where the ½-inch pipe must have a length of 256 yards, in order to furnish the same cubical capacity, we find that the area of its containing sides is

$$3 \times 0{\cdot}5 \times 256 \times 36, \text{ or } 13{,}824 \text{ square inches.}$$

The area of the sides of this ½-inch pipe is, therefore, 16 times greater than that of the shorter cylinder, and consequently every cubic inch of the explosive mixture consumed in the ½-inch pipe is exposed to an area of cooling surface 16 times greater than that which obtains in the other. By diminishing the diameter of the pipe still further we should at length arrive at such a condition of things that the cooling influence of the sides would prevent the transmission of flame by the explosive mixture. The circumstances would then be such that the temperature of ignition of the explosive mixture could not be maintained by its own combustion.

We have assumed in these imaginary experiments with cylindrical vessels that the pressure of the explosive mixture in their interior is equal to that of the atmosphere, and in so doing have only partially considered the case. When the pressure is greater than that of the atmosphere, we bring a new feature into the discussion.

RESEARCHES ON BEETROOT.

By A. BAUDRIMONT.

ON cutting open a beetroot, two series of concentric rings are observed, the one white and opaque, the other clear, transparent, and mostly colored; in the former the sugar is chiefly aggregated, and in the latter the albumen. The author has endeavored to promote the special growth of one or the other set of rings by the application of suitable manures. The roots were grown on four plots of land; one of these was treated with water, the rest in order with solutions of bicarbonate of ammonia, bicarbonate of potash, and a mixture of these. It was observed that the roots which had been watered with bicarbonate of potash solution were very large and hard, and consisted chiefly of the sugar bearing rings; those which had received bicarbonate of ammonia were much softer, hollow in the center, and the albuminous rings were more strongly developed; those treated with a mixture of both were not so hard, and showed clear albuminous rings, while those which had received water alone were the strongest, and showed both kinds of rings clearly. —*Bied. Centr.*

THE MANUFACTURE OF NITRO-GLYCERINE.

A NORTH ADAMS correspondent of the Boston *Herald* sends to that paper a description of the manufacture of nitro-glycerine at the Hoosac Tunnel. He says: About one hundred yards beyond the west shaft of the Hoosac Tunnel is to be seen a board fence, surrounding about ten acres of ground, with the announcement: "Nitro-glycerine works! Dangerous; no visitors admitted!" A drive leading between two rows of buildings brings the visitor to the acid house, a well-ventilated building, one hundred and fifty feet long. Here are eleven stills, each seven feet long and two feet in diameter. Under these a light, slow fire burns, which is carefully attended to, for the temperature must be kept moderate. In each of these stills is placed a charge of nitrate of soda and of sulphuric acid. A stoneware pipe conducts the gases, at a temperatue of about 180° Fahrenheit, from each still into a stone receiver or condenser, or rather a series of four condensers, connected by stoneware pipes, ranged on a platform three feet above the ground. Into three of these sulphuric acid is poured and the fourth is empty. The nitrous vapor passes from a still to the first condenser, where a portion of it, forming, as it condenses, nitric acid, is taken up by the sulphuric acid; the remainder passes on to the second, third, and fourth condensers, though a very small portion is left to pass into the last, which only requires to be emptied once a month. It takes about twenty-four hours for the still to complete the conversion of its contents into nitric acid, at the end of which time the resultant mixture, about six hundred pounds, is run off into carboys, twelve of these being filled from three stills. About one hundred carboys are generally kept in stock, as the acid does not spoil when kept closed. These carboys are then emptied into a soapstone tank, having a capacity of eighteen carboys, and an empty pipe, connected with the main leading from the blowers in the engine house, is

INSERTED INTO THE ACID,

causing a current of air to agitate it, so as to remove the nitrous fumes, mix it throughly, and bring it all to uniform strength. Formerly this was effected by removing the acid into a glass vessel containing about forty gallons, and it required boiling for hours; the mode now practiced occupies only five minutes, and the risk of fracture of a glass vessel in a sand bath is avoided. The acid is then carried into a converting room, about one hundred feet long and well lighted, where it is divided among one hundred and sixteen stone pitchers, arranged in nine wooden troughs placed in the center and at the end of the room, and these troughs are now filled with ice-cold water, or ice and salt, so as rise within four inches of the top of the jar. On shelves above the troughs are arranged glass jars, one to each stone pitcher. Into each of these glass jars chemically pure glycerine is poured, and this, by means of a siphon, with a rubber tube attached, about two feet long, falls, drop by drop, into the corresponding pitcher of mixed sulphuric and nitric acids. Immediately below the shelf on which the glycerine jar stands is a two and one-fourth inch iron pipe, which brings a current of cold air from the receivers connected with the two blowers above mentioned. This current of air is distributed to each jar, while the acid and glycerine are mixed by a rubber pipe, to which is attached a glass tube sixteen inches long and with a one-fourth inch bore. During the hour and a half or two hours that the glycerine takes to run off into the pitchers the greatest care and closest attention is required. The three men whose duty it is to attend to the mixing process have each a row of pitchers to watch, walking the whole time up and down beside them, with thermometer in hand, and, as the nitrous fumes rise from the forming nitro-glycerine, they stir the mixture with the glass tube, before mentioned, in a pitcher that may be giving out too violent fumes. Sometimes this may be caused by the glycerine running a little freely, which fires the mixture, wastes the glycerine, forming oxalic acid, and

DEVELOPS UNPLEASANT VAPORS.

In such a case, by pushing back a little wooden peg in the glass jar, the flow of glycerine is lessened, and by stirring with the glass tube the nitrous vapors dispelled. Should the engine stop working by any unforeseen circumstance, the current of air will, of course, be stopped, when the mixture will take fire. In this case it is necessary to stir the mixture and at once stop the flow of glycerine. When the glycerine and acid are all mixed and the nitrous fumes cease to appear, the nitro-glycerine from each pitcher is dumped into a large tank of water, at a temperature of 70°, about four hundred and fifty pounds of nitro-glycerine being the amount of each batch manufactured. The nitro-glycerine sinks to the bottom and is covered by about six feet of water. Here it remains for fifteen minutes, to be subsequently washed free from any impurities. This tank projects through the floor into a basement chamber, its bottom being on a slight incline, so that the nitro-glycerine may run out easily. The water is first drawn off from the top of the nitro-glycerine, and then the latter is run into a wooden swinging tub, in shape somewhat like an old-fashioned butter churn, but a good deal larger in diameter. In this it is washed five times, three times with plain water and twice with soda, a current of air working it at the same time. The water from this tub is run off into a wooden trough, which conveys it to a barrel buried in the earth, in the side of which a hole carries it to another barrel a little lower down the hill, and this into another barrel, whence it finds its way to the dump of rocks which were removed from the tunnel; any nitro-glycerine that may have escaped in the washing process being collected and retained in one or other of these three barrels. The nitro-glycerine is by this time thoroughly washed and ready to store in the magazine, three hundred feet distant, to which it is carried in a couple of pails. In the magazine the nitro-glycerine is

POURED INTO "CROCKS,"

as they are called, earthenware jars, holding sixty pounds. These crocks are then placed in a wooden tank two and a half feet deep, which holds twenty of them, and immersed to within six inches from the top of the jars in water warmed by a small pipe from the boiler to raise the temperature to 70°, at which temperature it is kept all the time, as nearly as possible. They remain in this water about seventy-two hours, during which time any impurities still remaining rise to the surface as scum and are skimmed off with a spoon. The nitro-glycerine is then chemically pure, transparent as water, refracts light powerfully, and is ready for packing. The tin cans, lined with paraffine, and containing fifty-six pounds each, are placed in a shallow wooden trough, and the nitro-glycerine, being poured from the crocks into copper cans, is again poured into the tins through a gutta-percha funnel, the bottom of the trough being covered with a thick layer of plaster of Paris, which absorbs and renders harmless any drops of nitro-glycerine that may be spilled. The tins are then placed in a wooden trough containing iced water or ice and salt, where the nitro-glycerine is slowly crystallized or congealed. In this condition it is stowed away in small magazines, three hundred feet distant, in amounts of thirty or forty cans each, until required for use. When the nitro-glycerine is to be conveyed to any point by teams the tins are packed in open wooden boxes, with two inches of sponge at the bottom and four rubber tubes underneath; these are long enough to allow the ends to come one inch over the top of the tin on opposite sides, thus interposing two elastic tubes between the outside of the tin and the inside of the wooden box, rendering it perfectly safe to carry. Each tin is cellular, *i. e.*, from the top of each tin to the bottom a tube passes, about ten inches deep and one and a half inches in diameter, for the purpose of throwing the congealed nitro-glycerine when the blaster is ready to use it, liquefaction being effected with water of 70° to 90°. The tins, being closed with a cork wrapped in bladder, are put into a sleigh or wagon, covered in summer with a layer of ice and blankets, and may thus be carried any distance in this purified crystalline state as safely as so many tubs of butter.

Perfect system pervades this factory, and it is necessary to insure safety. The steadiest men possible are selected for the work; three are employed in the acid house, working in three shifts of eight hours each, but they do not actually work more than seven hours. Every movement is like clockwork; every man has his place and special duty, which he is expected to perform at the proper time. In the morning, at 7 or 7:30, ten men dump the carboys of acid into the soapstone tanks and mix them, while a third is filling the glass jars with glycerine. This operation takes about an hour. One draws the acid, another weighs it, and a third carries it to the troughs. After an interval, during which the acids cool, three men attend closely to the converting of the glycerine into tri-nitro-glycerine. After the nitro-glycerine is dumped into the water tank two men are employed in washing it, while two wash the stone pitchers with water. The floors are kept scrupulously clean and perfectly free from atoms of nitro-glycerine, which, stepped upon while the men are at work, might send them to eternity and the building to smithereens. The room is then prepared for next day's operations, and by about 1 or 2 o'clock, after six, or, at most, seven hours' work, the day's work is done. Notwithstanding the extreme care used to avoid accidents, the Mowbray Works have been blown up three times, and of the nine competent superintendents that have been in charge, eight have been killed outright and their bodies blown to fragments, while the ninth is yet living, totally blind. The highest wages are paid, and, in order to render transportation easier and safer, Prof. Mowbray, within the past two years, has built a car expressly for the purpose.

NITRO-GLYCERINE.

THIS agent was discovered by Sobrero, in 1847. Its chemical properties have been fully investigated by Mueller, Dupré, Railton, and others. It is commonly prepared by what is known as Liebe's process. Half an ounce of dehydrated glycerine being poured with constant stirring into a mixture of two ounces oil of vitriol and one ounce fuming nitric acid of the specific gravity of 1·52—the temperature of the mixture being kept below 77° F. by external cooling with ice; and as soon as oily drops begin to appear on the surface, the mass is poured with constant stirring into fifty ounces of cold water. Nitro-glycerine then separates, and may be purified by washing and drying in small quantities in a vapor bath. It then appears as a sweet, opaque, milky looking, oily fluid, but on careful drying by exposure to heat in a warm room, or in flat dishes containing thin layers, it becomes dehydrated and forms a transparent, colorless, oily fluid. It is slightly soluble in water, and freely in alcohol and ether, as it is also in fats and oils. It is, although slightly volatile, inodorous, and has a sweet, pungent, aromatic taste.

This agent, until recently, has been known only in the arts, being principally employed as an explosive in mining and blasting operations, and forming the basis of the compounds known as dynamite, glyoxylon, dualin, etc. Something over twenty years ago some observations were made, having the possible therapeutic properties of the article in view. These were made by Mr. Field, of Brighton, England, but this gentleman having commenced with too large a dose experienced sensations which discouraged him from a further trial. Latterly, the article has been revived as a medicinal agent, by Dr. Murrell, of London, and it is principally through the reported results of this gentleman's experience that the article has assumed the importance which is now attached to it. Dr. Murrell's observations were made both on himself and friends and patients. His first experience with it was on applying the moistened cork of a bottle containing a one per cent. solution to his tongue. In a few minutes he experienced a violent pulsation in the head, which rapidly increased and soon became so severe that each beat of the heart seemed to shake the whole body. Subsequent observations on himself revealed this as one of the physiological effects of the drug. The acceleration of the pulse was found to be very constant, sometimes, however, not amounting to more than ten beats in a minute. The temperature remained unaffected.

The chief interest, of course, attached to the drug is connected with its practical application in the treatment of disease. For some time past it has been used as a remedy for neuralgia, but owing, probably, to the disagreeable effects liable to follow an overdose, it has not been submitted to that thorough trial in the disease which its properties would seem to merit. It is, undoubtedly, an anti-neuralgic of great value, and should have a thorough trial, especially in those cases, which are but too numerous, in which the usual remedies, quinine, phosphorus, strychnia, chloral, etc., have proved unavailing. Nitro-glycerine, however, is now chiefly remarkable for its decided properties in the relief of angina pectoris. It is largely employed in the London hospitals as a remedy against this most terrible of diseases, and certainly the results attending its use establish it as an article of great merit. A number of cases are reported in which a perfect cure has resulted from its employment. This is, probably, more than can be said of any other remedy. The article may be given either in solution or in the form of pills. The latter form has the advantage of assuring a greater uniformity in the dose, and is much more convenient for prescribing. The danger which might be supposed to result from the known terrible explosive property of nitro-glycerine is practically absent from the article in the form in which it is administered as a medicine. The pill mass may be thrown into the fire or beaten on an anvil with perfect impunity. The valuable properties which the drug has developed within the past year particularly, will result in fixing it as one of the standard remedies in the class of diseases in which it has thus far been recommended. Doubtless it will develop other properties with a more extended trial, and indeed, it has already been spoken of as an efficient diuretic.—*Therapeutic Gazette.*

DETECTION OF COTTON-SEED OIL IN OLIVE-OIL.

By BENJAMIN NICKELS, F.C.S., F.I.C.

A CONTINENTAL firm (consumers of oils) consulted with me on a recent occasion as to the simplest method of detecting admixtures of "cotton-seed oil" with "Lucca or Gallipoli," making a strong point of the want of such a test among customers. Without entering upon the admitted difficulty of the case as regards the chemical aspect of the question, it has occurred to the writer that something might be done in the direction indicated by spectroscopic examination.

Pure "olive or Gallipoli," as examined by a Browning "direct vision" or pocket instrument, presents a deep shadowing or cutting-out of the blue and violet ray, with a fine, almost indistinct, line in the green, and a strong deep band in the red.

Refined cotton-seed oil similarly examined presents exactly the same appearance, but as regards the blue and violet ray only, the green and red being continuous.

Now if we take as a standard a given stratum of pure olive or Gallipoli, say in a test-tube $\frac{5}{8}$ or $\frac{3}{4}$ in. in diameter, and a similar stratum or thickness of the standard oil in admixture with cotton-seed, there is no discernible difference as regards the shadowing in the blue and violet ray, but an almost entire fading out of the delicate line in the green, and a considerable diminution in the depth and intensity of the strong band in the red, consequent upon "dilution" or "thinning down." With 50 per cent. in admixture the loss in intensity is considerable; with 25 per cent. the variation is marked and discernible.

A suspected sample compared with and differing thus from the standard, and in the absence of any direct chemical evidence as to the nature of the oil in admixture, might fairly fall within the range of strong presumptive evidence pointing towards "cotton-seed" oil as the probable dilutant.—*Chemical News.*

ARTIFICIAL PRODUCTION OF FELSPARS CONTAINING BARIUM, STRONTIUM, AND LEAD.

By F. FOUQUÉ and A. M. LEVY.

BY heating mixtures of silica, alumina, sodium carbonate, and strontia, baryta, or lead oxide, in the requisite proportions to a temperature just below their fusing points for forty-eight hours, crystalline masses are obtained which correspond in composition to oligoclase, labradorite, and anorthite, but contain baryta, strontia, and lead oxide in the place of lime. These crystals resemble felspathic microliths in their behavior with polarized light, and one of the axes of elasticity coincides with the direction of elongation. The anorthite of baryta is probably orthorhombic, the labradorite of lead is decidedly triclinic, but the determination of the crystalline forms of the other compounds could not be made with certainty. The macle of albite, characteristic of triclinic felspars, was not observed on the artificial products. They all scratch glass, and with the exception of the oligoclases of baryta, strontia, and lead, and the labradorite of strontia, are attacked by acids. Their specific gravities are given in the following table:

	Strontia.	Baryta.	Lead.
Oligoclase	2·619	2·906	3·196
Labradorite	2·862	3·333	3 609
Anorthite	3·043	3.573	4·093

None of these artificial products corresponds with the natural triclinic barytic felspar recently described by Descloizeaux (*Bull. Soc. Min.*).—*Compt. Rend.*

DOMESTIC REMEDY FOR FELONS.

By T. C. BRANNON, M.D.

I HAVE been afflicted with nearly forty felons during my life, and suffered very much with the first ones, being able to get no reliable treatment from medical authorities. In my desperation I resorted to the many treatments kindly suggested by old ladies, and finally succeeded in learning how to abort the inflammation. Felons are generally, if not always, caused from bruises, and originate under the periosteum.

How to diagnose a felon.—When the palmar surface of the finger, thumb, or any part of the hand feels as if a fine, sharp, short thorn had entered the cuticle, and the outer end had become embedded beneath it, and when, on "picking" for it, it seems to be pressed into the periosteum, endways, and you fail to find the thorn, and know no other cause for redness, swelling, and pain, you may rest assured that you have a felon coming. But if you wish to further satisfy yourself whether or not it is a felon, take your pocketknife and rub the edge over the small, red spot, inclining the back of the blade forward. Notice if, when you are passing over the diseased spot, the red corpuscles are all caused to pass on through the blood vessels, leaving the inflamed part whitened for a short time after the knife passes over it. If not, it is apt to prove to be a felon.

I give rules for diagnosing the disease in its forming stage, when it is easily aborted by my treatment; but if neglected longer, it only succeeds in part, according to the deposit under the periosteum:

Treatment.—I have used the following simple treatment for twenty-three years, since which I have always succeeded in aborting this painful disease, or modifying the great pain, and not unfrequently preventing the loss of one joint of the finger: Take of soft lye soap and flaxseed meal a sufficient quantity, stirring the meal in slowly with spatula, or case-knife, manipulating thoroughly, so as to form a salve or poultice. Cornmeal is a good substitute for the flaxseed. Envelop the finger in this, applying snugly, and occasionally pressing it to bring it more completely in apposition. Renew the poultice every twelve to twenty-four hours. Don't try every prescription you may hear of. Depend on this, and this alone. It will, if applied in time, abort the disease; if adopted later, it will bring it to a small "head" (if too far advanced to be "scattered"), when it may be picked almost painlessly.

The escharotic properties of the soap soon destroy the thick skin over the region of the disease, which accounts partly from the quick relief from pain. Besides, I think it is partially absorbed, and thus affects, more or less, the diseased process.—*Therapeutic Gazette.*

THE CONTAGION OF CONSUMPTION.

By James T. Whittaker, M.D., Professor Theory and Practice of Medicine, Medical College of Ohio.

The most important question now engaging the attention of the medical world is the contagion or the communicability of consumption. Clinicians here and there have from time immemorial held the view that consumption was contagious. The authorities, from age to age, who have made themselves such by the close study of the disease, have died of it. Such was the fate of Bayle, Young, Laennec, and many others. Riverius made the observation as long ago as 1668, that members of a family have one after another succumbed to the disease. Contagion he declares to be the "chiefest" cause of phthisis; "for this disease is infectious. We may observe women to be infected by their husbands and men by their wives, and all the children to die of the same, not only from infection of their parent's seed, but from the company of him that was first infected." Similar observations have been made in every decade since, and yet any general acceptance of the infectiousness of phthisis never obtained until the disease was inoculated in lower animals, first of all two hundred years later by Villemin, 1865. The value of experimentation on the lower animals has never been so conclusively demonstrated as by the confirmation thus afforded of the specificity of the tuberculous virus.

It is worth while, however, to notice the force of the convictions of some of the clinicians from mere bedside observations.

Before his death, nearly fifteen years ago, Budd, one of the shrewdest clinicians who ever lived, wrote:

"The following are the principal conclusions to which I have been led regarding phthisis or tubercle:

"*First.*—That tubercle is a true zymotic disease, of specific nature, in the same sense as typhoid fever, scarlet fever, typhus, syphilis, etc., are.

"*Second.*—That, like these diseases, tubercle never originates spontaneously, but is perpetuated solely by the law of continuous succession.

"*Third.*—That the tuberculous matter itself is (or includes the specific morbific matter of the disease, and constitutes the material by which phthisis is propagated from one person to another, and disseminated through society.

"*Fourth.*—That the deposits of this matter are therefore of the nature of an eruption, and bear the same relation to the disease, phthisis, as the yellow matter (the stools), for instance, of typhoid fever.

"*Fifth.*—That by the destruction of this matter on its issue from the body by means of proper chemicals, or otherwise, seconded by good sanitary conditions, there is reason to hope that we may eventually, and possibly at no very distant time, rid ourselves entirely of this fatal scourge."—*The London Lancet*, October, 1867.

Dr. W. H. Webb, of Philadelphia (who entertained the idea "which came into his head unbidden, so to speak, while walking on Observatory Hill near Clifton, in the second week of August, 1856"), in a paper, "Is Phthisis Pulmonalis Contagious, and does it belong to the Zymotic Group?" read before the Sydenham Medical Coterie of that city in 1878, quotes from Hippocrates, Galen, Riverius, Morton, Van Swieten, Baume, Cullen, Heberden, E. Darwin, Goode, S. G. Morton, Bright and Addison, Laennec, Hastings, Drake, Walshe, Copland, J. Frank, Hufeland, and Hildebrand, in support of this view. Dr. E. Holden, in the same year, in response to inquiries addressed to 250 leading physicians of the United States, obtained from 126 an expression of belief in the communicability of consumption. Yet, notwithstanding this array of authority, physicians generally are so little convinced of the infectiousness of tuberculosis as to experience and express surprise when the statement is made anew from time to time.

What has especially prevented the general acceptance of the infectiousness of tuberculosis is the widespread belief in the almost exclusively hereditary transmission of the disease. Of this transmissibility there is no shadow of doubt, but, fortunately for the human race, heredity does not account for even the majority of cases. Because members of the same family succumb to the disease, is not so much proof of the influence of heredity as of contagion, for a like implication is seen in all kinds of infectious disease among individuals in close association. And it is the observation of every practitioner of experience that a large contingent of cases develop entirely independent of heredity. To invoke the possible existence of the disease in the remote ancestry or distant relationship is a safe refuge, of course, because no generation escapes in all its members; but such an explanation savors too strongly of the metaphysics of the middle ages to satisfy the more accurate demands of modern times. That phthisis is acquired oftener than inherited is a fact which becomes more patent every day.

The pathologists finally reached the same conclusion in the slow evolution of their investigations. At first consumption was an ulceration of the lungs. Then solid masses were encountered, nodules or tubercles. The nodules were observed to be of smaller and smaller size, even down to granules. So, Hippocrates and Galen speak of ulcerations and suppurations. Sylvius, 1640, first found the nodules which he believed to be pulmonary glands. Bonnet, 1679, speaks of small tubercles which Mangetus, 1700, compared to millet-seeds. Baillie, 1793, distinguished tubercles from pulmonary glands, and Bayle, 1810, recognized them as developed independent of ordinary inflammations. Laennec, 1810, shows that the different kinds of tubercle, which are new formations, represent different ages of the same products. "The recent progress of anatomy," he says ("De l'auscultation médiate," etc., p. 10), "has shown that these cavities are due to the softening and consecutive evacuation of a *particular kind of accidental production* (italics ours), to which modern anatomists have applied especially the name of *tubercle*, a term used in general, hitherto, for every kind of tumor or abnormal protuberance." Rokitansky, 1842, like Louis before him, adopted the view of Laennec, that tubercles are neoplasms, and are consequently specific and, *sui generis*, a support, as Ruehle remarks, which "seemed to at last definitely prove the specific nature of phthisis."

Such was the prevailing doctrine regarding tuberculosis up to the time of Virchow, 1847. This distinguished pathologist claimed to demonstrate the development of tuberculosis from any caseous matter, and caseous matter in turn from any necrobiosis of tissue. The view so clearly presented by Carswell, 1813, that consumption might result from any ordinary inflammation was thus reinstated, and at the hands of Niemeyer, 1867, a clinician of the cellular pathology school, so plausibly elaborated as to set back the specificity of tuberculosis for several decades. According to Niemeyer a catarrhal pneumonia developing in a healthy constitution has its effused products undergo fatty degeneration and absorption, with resolution of the disease; but, developing in a so-called "vulnerable" constitution, the inflammatory products undergo caseous degeneration and remain. The disease is now known as caseous pneumonia (phthisis). The absorption of the caseous matter in turn produces a peculiar blood-poisoning which is known as tuberculosis. So, tuberculosis was a tertiary factor incident to the absorption of caseous matter, itself a secondary matter incidental to a catarrhal inflammation in a vulnerable constitution. These conclusions, as consecutively put as the chain of catastrophes in the house that Jack built, passed into general favor at once and were quoted on every hand. But they were fatal to any further progress in the domain of tuberculosis. A tuberculous patient was doomed from the start, because he had already in his original construction a "vulnerable constitution," and he was hurt in the vulnerable part.

As might be well imagined, clinicians generally could not rest content with this gloomy outlook upon a disease which destroys, according to Hirsch, two-sevenths of mankind. We may, therefore, readily appreciate the thrill which was occasioned everywhere by the first experiments of Villemin in 1865, demonstrating that tuberculosis, in any of its products, was inoculable. Tuberculous matter introduced beneath the skin of a rabbit or guinea pig produced tuberculosis. So-called control experiments were generally instituted at the hands of numerous observers. From these experiments it seemed to be proven, first that the disease thus induced in lower animals was not the tuberculosis of man; second, that other noxious agents, like decomposing meat, or even innocuous substances, like elder pith or India-rubber, would produce the same symptoms; and, third, that the so-called tuberculosis thus induced was the result simply of the absorption of caseous matter produced in any way. The death blow seemed thus to have been dealt to the infection theory, and the therapy of tuberculosis was left in the same deplorable state as before. It remained now only for the pathologists, as a question of purely scientific interest, to develop caseous matter in the lungs. Given the caseous matter and the problem of tuberculosis was solved. Soon it came to be observed, however, that croupous pneumonia, that is, our so-called frank pneumonia—in our nomenclature lobar pneumonia—never terminated in caseous degeneration. Since the publication of the remarkable paper by Juergensen, lobar pneumonia, far from being a frank, typical inflammatory disease, has become an acute infectious disease of cyclical course, with a crisis, a typical temperature curve, and a definite duration. Croupous pneumonia had therefore to be ruled out of the etiology of tuberculosis. Next it was seen that catarrhal pneumonia, our lobular pneumonia, or sometimes our capillary bronchitis, seldom or never furnished the desired caseous matter for further infection. So it was left them for Buhl to invent or discover a new form of pneumonia, to wit, the desquamative pneumonia, whose object it was apparently to develop the caseous matter.

The subject of tuberculosis stood now about as follows: According to the views of the pathologists, with Buhl at the head, phthisis or tuberculosis was a resorptive disease. It resulted from the absorption into the blood of caseous matter. This resorption might occur at any time, and when it did occur, it was necessarily fatal in its effects. According to the clinicians, with Niemeyer at the head, there was no therapy for the disease beyond a general building up of the body, including everything that is meant by a more perfect hygiene. Bad air and bad food, bad sewage, overcrowding, any defective hygiene, might cause the disease, and the only hope for mankind lay in sanitation.

So phthisis was a disease without a therapy. Symptoms might be met and prostration relieved for the time being, but there was no future for the victim of the disease. True, clinicians had occasionally observed that most individuals recover from the disease; that *post mortem* examinations upon individuals dead from other affections, or killed by accident, showed the presence of encysted or degenerated tubercles at the apices of the lungs, sometimes unsuspected during life; that it was exceptional, in fact, to find lungs free from all tuberculous deposit. The view now began to prevail that phthisis was a self limited disease; it might run a definite course, of indefinite duration, and then be expelled from the body, provided the body could be in the meantime sustained.

Some inexplicable cases of basilar meningitis began to be observed. For the most part, brain tuberculosis had been considered as a typical illustration of the heredity of the disease. In every case, or in every suspected case, the practitioner would make anxious inquiry regarding ancestral phthisis. But cases were encountered where no such antecedence appeared. Thus, Reid reported ten cases in the *Berlin. Wochenschrift*, Sept. 18, 1878, to all of which the disease had been clearly communicated by a phthisical midwife, who subsequently died of the disease, and in none of which could there be traced any history of hereditary phthisis. Tubercular meningitis, like bone tuberculosis, had hitherto been regarded as an invincible argument against any reception of the disease from without, and the occurrence of cases of either among individuals free of its inheritance constituted a stumbling block in the pathology of the disease, which could only be surmounted by the theory that tuberculosis might result from any ordinary catarrhal or traumatic inflammation. A little later came the observation of Tappeiner, to the effect that dogs shut up in a box whose air was impregnated with atomized phthisical sputa, inevitably died of the disease. Jacobi had long reported the case of a dog who had died of tuberculosis from eating the sputa of his phthisical master, and occasional cases of like import have found their way into medical journals from time to time since, the last in a recent number of the *British Medical Journal*. Here was now a new insight into the nature of tuberculosis. Cohnheim and Solomonsen now made their famous experiments upon rabbits, and found that tuberculous matter introduced into the eye or other organ invariably produced first local and afterward general tuberculosis, and that tuberculosis could be produced in no other way. What made these experiments especially valuable was the fact that they were undertaken in the spirit of skepticism. For Cohnheim was himself the most authoritative opponent of the specificity of tuberculous virus when the theory was first promulgated by Villemin. Cohnheim found that the introduction of the smallest particle of tuberculous matter through a lineal incision into the eye of a rabbit was followed, after a period of incubation of about six weeks, by an eruption upon the iris of minute nodules "which increase to a certain size, and then undergo caseous degeneration, to be followed, in turn, in the course of months, by a more or less general tuberculosis of the lungs, peritoneum, and various other organs." Cohnheim is so convinced of the inoculability of the virus that he proposes to utilize it as a diagnostic criterion of tuberculous products. We are unable, he says, to differentiate tuberculous matter with certainty in any other way. "Neither the nodular form, the histological structure, the occurrence of giant cells, caseation, nor all these circumstances together, are absolutely characteristic of tuberculosis. *The only absolutely perfect and certain criterion is the capacity of infection.*" The products of local tuberculosis are just as inoculable as those of general tuberculosis, hence the disease process is essentially the same. Phthisis pulmonalis is a local tuberculosis. The ingestion of its products, or the ingestion of tuberculous virus with the food, as in the milk of tuberculous cows, begets intestinal tuberculosis. Scrofula is a more or less local tuberculosis, the virus being still confined to the lymph glands in the vicinity of the place of its absorption. The caseous swellings of the cervical lymph-glands are thus explained. According to Weigert, the virus may reach the brain by inspiration through the cribriform plate of the ethmoid bone, and thus induce basilar meningitis first. Primary bone and joint tuberculosis presuppose the existence of the virus in the blood, and the extravasation of it in greater quantity at the affected regions. The implication of the pulmonary veins or thoracic duct—conditions encountered in *post mortem* examinations of such cases—lead to a profuse inundation of the juicy organs with tuberculous virus, and account for the cases of rapid and universal dissemination, the cases of so-called acute miliary tuberculosis.

The whole question of the contagion of consumption, *i.e.*, of the specificity of the tuberculous virus, hinges upon its inoculability, and of this capability there is now scarcely room for doubt. Harnsell (Graefe's *Archiv*, 25, part iv., 1879) mentions cases of tuberculosis iridis, as reported by Perls, Manfredi, Koester, Leber, Samelsohn, Sattler, and Angelucci, and adds three cases from his own (Gottingen) clinic. He thus establishes the fact of infection of the iris. After mentioning the experiments of others in direct and indirect inoculation of the eye with tuberculous matter, the author then proceeds to detail his own. He found that the insertion of tuberculous matter into the anterior chamber of the eye invariably inoculated the iris. The cornea and conjunctiva, moreover, could be inoculated directly, and in all cases the tuberculous matter inserted "disappeared by the third day, and after from fifteen to twenty-three days of incubation tuberculous collections showed themselves."

The fact that these collections or masses were tubercular was proven after the method of the chemists in recognition of the action of a poison, that is, by insertion into the bodies of other animals. Particles or portions were put into the abdominal cavities of dogs and guinea-pigs. The dogs died of suppurative peritonitis. The guinea-pigs were kept under observation for three months and then killed, when "all the internal organs and the skin were found, without exception, to be filled with deposits of miliary tubercles." Cohnheim tried in vain to excite tubercles in the iris "by introducing into the anterior chamber portions of non-tuberculous animal tissues of the most varied kind," and Harnsell failed to inoculate tuberculosis with fresh trachomatous matter. "On the other hand, the tuberculous matter used when introduced into the peritoneal cavity, excited, in turn, general tuberculosis of all the organs."

"*So in tuberculosis*," as Cohnheim concludes, "*everything depends upon the virus. We discover at all points the closest analogies between tuberculosis and syphilis. Both require, above all things, infection, transmissibility of the disease from person to person.*"

This comparison between tuberculosis and syphilis is exceedingly happy. The conduct of no other infectious disease so closely resembles that of tuberculosis, or so completely clears up the perplexities which beset the disease. To compare tuberculosis with small pox, for instance, would be fatal to our understanding of either, while tuberculosis and syphilis present so many analogies as to have even led some pathologists to regard one as a form or a product of the other, a conception which is, of course, radically wrong.

Tuberculosis, like syphilis, depends then upon a specific virus which must reach a mucous membrane or a broken surface, to be absorbed and induce the disease. Laennec was convinced that he had inoculated himself once with tuberculosis, just as many an unfortunate practitioner has since inoculated himself with syphilis, by a wound from a saw in making a *post mortem* examination upon a phthisical patient. But more fortunate than they, he succeeded in destroying the tuberculous nodule at the start with the butter of antimony.

Syphilis, for the most part, reaches the body through the organs of generation, while tuberculosis is breathed, for the most part into the lungs, or is swallowed with food, as with milk, the most frequent cause of tuberculosis in childhood.

The first symptoms of each affection are local: in syphilis, at the genital organs; in tuberculosis, at the lungs or in the intestinal canal. From the point of absorption the disease next invades the lymph glands in the nearest vicinity: in syphilis, the glands in the groin; in tuberculosis, the bronchial and mesenteric glands. Passing these glands, or being absorbed into the blood, both diseases become general.

Both diseases may be transmitted by heredity, and both diseases, thus transmitted, may lie latent for a time, for a longer time in tuberculosis, to develop at a later period. During the latent stages, both diseases impair the processes of nutrition, and deform the development of the body. The victim of latent syphilis has notched teeth, falling hair, derangements of digestion, etc. The victim of tuberculosis shows the aspect of scrofula, or has the sunken, elongated chest, ossified ribs, the thorax paralytica; he has also clubbed fingers, and the other well known signs which constitute the *phthisical habitus*. This habitus is, therefore, an effect and not an inviting cause of the disease. An individual thus affected is said to have the tuberculous diathesis, just as an individual once syphilized has the syphilitic diathesis. Either disease may manifest itself in its well known symptoms at any time. But latent or manifest, the disease is present, just the same, all the time.

There is, then, no such thing as a predisposition to either disease. Either a man has syphilis or he has it not. Either a man has tuberculosis or he has it not. One man is not more predisposed to either disease than another. Syphilis affects one individual more than another, because its virus finds a better lodgment upon his mucous membranes. Tuberculosis finds also, fortuitously, a better nidus in one case than another. The virus of tuberculosis is lodged in one case and not coughed up, just as in syphilis the virus is secreted and not washed off.

Both diseases may disappear from the body entirely, and a perfect cure may result, but it is impossible to state when such complete eradication has taken place. In syphilis the capability of reinoculation furnishes the only definite information in this regard, a method of trial not so likely to be undertaken in tuberculosis. As a rule, however, neither disease does disappear from the body entirely. What Fournier said of syphilis is true also of tuberculosis, viz., that the diathesis is a period of health interrupted by explosions of the disease. Cazenave said long ago that one

does not recover from the syphilitic diathesis, but lives with it as with the lymphatic temperament, and an old writer observed that syphilis strikes with its victims "a truce oftener than a peace."

Both diseases may and for the most part do leave in the body centers of future infection. From any chancre, plaque, gumma, or other deposit of syphilis, reabsorption may take place at any time, and reinfection with syphilis, or, better, reappearance of external signs. So, from any caseous nodule wherein the tuberculous virus is locked up in temporary innocence, absorption may take place under favoring circumstances and a new outbreak of tuberculous symptoms appear, the quantity of the virus thus set free determining to great extent, perhaps, the virulence of the symptoms. While the virus is thus locked up, the disease is latent; when set free, it is manifest.

While it is true, therefore, of both diseases that they may be inherited, that is, that both syphilis and tuberculosis may affect the ova and spermatozoids as well as every other organ and tissue of the body, it is also true of both diseases that they are in the vast majority of cases not inherited, but acquired. A thorough sifting of the cases will show this statement to be as notoriously true of tuberculosis as of syphilis. So soon as the inoculability of tuberculosis is established, the fact is also established that the disease is acquired oftener than inherited.

With the general recognition of these views, we shall cease to hear of bad air and bad sanitation as direct factors in the disease. The writer of this article once went so far as to develop tuberculosis from depressing mental emotions. Bad air, food or drink, are productive of tuberculosis only when they contain the virus of the disease. In other respects they are no worse for tuberculosis than for any other disease. Drinking water contaminated with sewage does not produce typhoid fever unless the sewage contain the typhoid germ. So, contaminated air is productive of tuberculosis only when a cause of its contamination is tuberculous virus. Drs. Cotton and Edwards, of the Brompton Hospital for Consumptives, object to the contagiousness of consumption on the ground that but one nurse and one servant died of phthisis in that institution in a period of twenty-one years. Dr. Cotton went so far as to say that "a residence in the consumptive hospital and long continued working in its wards is a very good way, indeed, *not to catch the disease.*" It must be remembered, however, that few institutions were in such perfect sanitation, especially as regards ventilation, as Brompton Hospital. Anyhow, the statement does not count for much else than to show how close an association is necessary to contract the disease. For the same observation has been made with reference to typhoid fever, an infectious disease beyond a doubt. Liebermeister states that up to the year 1865 he had never seen in the hospitals which he visited (Greifswald, Berlin, Tubingen), "a single hospital patient, physician, or nurse, attacked with typhoid fever, although such cases are placed in the general wards." "And the same author quotes from Murchison to the effect that "during a period of fourteen and a half years in the London Fever Hospital, 2,506 patients were treated with typhoid fever, and during that time only eight cases originated in the hospital."

The specificity of the tuberculous virus is determined in a higher school, and by means more in accord with the principles of science than clinical observation. And the recognition of it clears the field for prophylaxis and opens up a new and more promising outlook for the therapy of the disease.—*Medical Record.*

REPORT ON DISEASES OF DOMESTIC ANIMALS.

By JAMES LAW, Professor of Veterinary Medicine in Cornell University.

DR. J. L. CABELL:

SIR: In compliance with your request, I respectfully submit the accompanying statement as to how far in my opinion the functions of the National Board of Health must embrace a superintendence of the sanitary condition of the domestic animals. I have considered such animal diseases as determine specific and communicable disorders in man, and have sought to point out in what cases the gravity of the affection would demand the interference of a health board. A large number are mentioned over which a national board of health must exercise a careful supervision if they would fulfill their trust; and to enable them to accomplish this, Congress must give them power to add to their number men who have made a special study of animal diseases, and who are prepared to cope with them successfully. I have further sought to show how essential it is that a board so constituted should be invested with executive power and not left as a mere advisory body, which must lose in intelligence, efficiency, and esteem in proportion as it is debarred from the practical work of overcoming insanitary conditions and of instituting experiments to determine the best methods of sanitation.

Finally, I have entered on the question of those affections of the domestic animals which are not communicable to man, but are transmissible from animal to animal so as to constitute veritable plagues and to undermine our agricultural prosperity. As agricultural success is the true basis of all national prosperity, the suppression and extinction of these animal plagues is a work only secondary in importance to the arrest of epidemics, as national wealth is only second to moral advancement.

Here arises the question, whether a board of health already constituted to deal with a certain number of animal plagues is not the most economical and efficient medium through which to deal with all, and whether the whole subject of animal sanitation should not therefore be placed in the same hands? In seeking to take an impartial view of this matter, I have taken into account the financial interests involved, and the necessity for a representation of these interests in any organization appointed to deal with the subject. I have also considered the great expenditure necessary to a prompt extinction of the exotic animal plagues, and the need of an executive head who can act promptly in every emergency and without the fatal delays that would attend on calling meetings of a health board whose members reside at long distances from each other; also, the vast importance of a speedy extinction of exotic plagues before they can gain a footing on the plains and boundless unfenced pasturages of the West and South, from which it would be hopeless to attempt their extermination. And, finally, the imperative need of prompt and effective work in order that the country may be made aware of the advantages of such an executive, and that there may be no excuse for a temporary—perhaps, a final—abolition of the organization before they have had an opportunity to exterminate a single plague, and thereby to demonstrate their value to the nation.

In view of these and other considerations an opinion is respectfully submitted, which is, at least, the result of no hurried conclusion, but of careful deliberation.

LIST OF COMMUNICABLE ANIMAL PLAGUES.

As the magnitude and gravity of this subject is but little appreciated, it will be best introduced by stating, in tabular form, the diseases of the domestic animals that are known to be communicable to man, and those which are intercommunicable between animals only. Afterward, the question will come up as to which of these diseases will demand the supervision of a health board, and under what circumstances.

A.—*Contagia common to man and animals.*

1. Glanders and farcy in horses, etc.
2. Canine madness, rabies in dogs, cats, etc.
3. Malignant anthrax in all domestic animals.
4. Tuberculosis in all animals.
5. Asiatic (malignant) cholera in all animals.
6. Milk-sickness in cows and other animals.
7. Small-pox in chickens, pigeons, etc.
8. Eczematous (aphthous) fever in bisulcates, etc.
9. Typhoid fever (?) in sucking animals.
10. Diphtheria in animals.

B.—*Parasites common to man and animals.*

1. Echinococcus in animals; Tænia echinococcus in dogs.
2. Cysticercus cellulosa in swine; Tænia solium in man.
3. C. medio-cannellata in calves; T. medio-cannellata in man.
4. C. tenuicollis in man, sheep, etc.; T. marginata in dog.
5. Tænia elliptica in man and cat.
6. Bothriocephalus latus in man, dog, etc.
7. B. cordatus in man, dog, etc.
8. Trichina spiralis in swine, etc.
9. Tricocephalus dispar in man and pig.
10. Strongylos gigas in man, horse, ox, and dog.
11. Ascaris mystax in cat and human being.
12. Fasciola hepatica in man, herbivora, and omnivora.
13. Distomum lanceolatum in man, herbivora, and omnivora.
14. Pentastoma tænioides in man, dog, sheep, etc.
15. Sarcoptis mutans in chickens and man.
16. Demodex folliculorum in dog, sheep, and man.
17. Æstrus bovis and other cuticolla in cattle and man.
18. Gregarina in man and animals.
19. Tricophyton tonsurans in man and animals. (Tinea tonsurans.)
20. Achorion schonleini in man and animals. (Tinea favosa.)
21. Microsporon adonini in man and animals. (Tinea decalvans.
22. Oidium albicans in man and animals. (Thrush. m. uguet.)

C.—*Contagia communicable from one animal to another.*

1. Texas fever in cattle.
2. Swine plague. Intestinal fever of swine. Hog cholera.
3. Bovine lung plague. Contagious pleuro-pneumonia in cattle.
4. Rinderpest in cattle and other ruminants.
5. Sheep-pox. Variola ovina.
6. Swine-pox. V. suilla.
7. Cow-pox. Horse-pox.
8. Venereal disease of stallions. Dourine.
9. Foot-rot in sheep.
10. Strangles in horses.
11. Influenza in animals.
12. Infectious mammitis in cows.
13. Parturition fever in ewes.
14. Quebra bunda in horses.
15. Horse sickness of South Africa.

D.—*Parasites causing enzootics in animals.*

1. Scabies acariasis:

In sheep:
- Follicular scabies. Demodex folliculorum.
- Scab. Dermatocoptis ovis. / Dermatophagus ovis.
- Black nose. Sarcoptis ovis. (Leptus Americani ?)

In horse:
- Mange. Sarcoptis equi. / Dermatocoptis equi.
- Poultry mange. Dermanyssus avium, etc.
- Foot mange. Dermotophagus equi.

In ox:
- Mange. Dermatocoptis bovis.
- Foot mange. Dermatophagus bovis.
- Poultry mange. Dermanyssus avium, etc.

In pigs and dogs, mange. Sarcoptis suis (Squamiferous).

In dog:
- Mange. Sarcoptis squamiferous (Suis).
- Follicular mange. Demodex folliculorum.

In cat and rabbit, mange. Sarcoptis nivar.

In chicken, scabies:
- Sarcoptis mutans.
- Dermanyssus avium.

2. Lung worms:

In sheep, goat, and camel:
- Strongylus filaria.
- Strongylus filaria, varietas longus.
- Strongylus Africana.

In horse and ox, strongylus micrurus.
In swine, Strongylus elongatus.
In birds, gapes. Sclerostomum syngamus.

3. Sclerostomum hypostomum in sheep.
4. Strongylus filicollis in sheep.
5. Strongylus contortus in sheep and cattle.
6. Sclerostomum equinum in horse.
7. S. tetracanthum in horse.
8. S. suis in swine.
9. Tricocephalus affinis in cattle and sheep.
10. Stephanurus dentata in swine.
11. Echinorynchus gigas in swine, cockroach, ladybug, etc.
12. Ascaris suilla in swine.
13. Tænia expansa in sheep and cattle.
14. Cœnurus cerebralis in sheep, cattle, dogs, etc.
15. Œstrus ovis, grub in the head, in sheep.

In presenting this formidable list of diseases it must not be supposed that we advocate an immediate resort to suppression of the whole. A very few only will demand prompt and active suppression. For others, even of the most dangerous character, there is only wanted a guardiancy over trade to prevent the importation of disease or its extension into regions where it would be seriously detrimental. While for most places it will be at long intervals only and in special conditions that the resulting disease will arise to the dignity of an epizootic or epidemic and demand executive interference, yet there are few maladies mentioned above that may not and do not in particular circumstances attain to such dimensions, and a national board of health, charged with the supervision of the sanitary condition of animals as well as men, must be prepared to meet and successfully deal with any one of the above affections to which the human being is subject. Similarly, must an organization, formed to deal with the plagues peculiar to animals, be prepared to deal with any one of those affections when it attains to dangerous proportions.

GLANDERS AND FARCY.

This affection, which so remorselessly ravaged the cavalry regiments and mule trains during the recent American war, was, at the return of peace, scattered widely over the continent. In country districts we continually see it cropping out, and whole studs falling victims to its ravages, while in city car stables hundreds are not unfrequently slaughtered to arrest the progress of the scourge.

The subjects of the slight and chronic attacks are frequently taken to a distance and sold as sound animals to unsuspecting purchasers, whose health and lives are thus too often sacrificed to satisfy the cupidity of an unscrupulous vender; for this terrible malady is as painful, loathsome, and fatal to the human system as to the equine, and every veterinarian of extensive practice can adduce instances in which men have perished miserably from the equine infection.

Were it only for the money losses inflicted by this scourge, it would demand the prompt destruction and safe disposal of every infected animal.

At the beginning of the present century, horses suffering from chronic glanders were habitually kept and worked in Great Britain, and the losses throughout the island were enormous. Now, where it is illegal to keep a glandered horse, these have been reduced to a very limited number. In the English army, where the presentation of symptoms equivocating glanders entails the prompt slaughter of the subject, this disease has been definitely eradicated, and a former loss of ten per cent. per annum has been entirely obviated. When we add to this the moral and economic considerations of the preservation of human health and life, the demand for the instant destruction of animals afflicted with this disease becomes imperative. A statute looking to this end is demanded in all States in which it has not been already enacted, and it becomes the duty of the National Board of Health not only to urge the passage of such a protective law, but to see that it is properly administered. That such a supervision is necessary may be inferred from the facts: 1st. That many of the most dangerous forms of glanders show deposits only in the lungs, testicles, or other distant and deep-seated organs, and these would escape the detection of an ordinary observer, or, indeed, of any one excepting a thorough and accomplished veterinarian, and the subjects of such deposits would be preserved for months or years to spread the disease; 2d. That to extirpate the disease when it has broken out in a stud or locality, it is not enough to dispose of the infected beasts, and to thoroughly cleanse and disinfect the premises and movable objects, but this must be followed, when requisite, by an improvement of the hygienic conditions of the stud, and especially in the matters of ventilation, work, and alimentation. In the case of a disease like glanders, so fatal to both man and horse, the infected horse should be slaughtered as would a venomous reptile, without any considerations of indemnity. The laws under which the destruction is effected should, if possible, be State and municipal, so as to make their administration the especial duty of the local magistrates; but it should be made incumbent on all good citizens to notify such authorities in all suspicious cases, and in case of uncertainty as to the true nature of the disease or indisposition to administer the law, the National Board of Health should be the court of appeal empowered to institute an examination and see that the law is enforced.

CANINE MADNESS, RABIES, HYDROPHOBIA.

In canine madness, we confront a disease which even more than glanders demands restrictive measures. The glandered horse is dangerous mainly to those who voluntarily approach him, and he shows no mischievous propensity to inoculate other animals or man with his dreadful infection. But the rabid dog seems as if the impersonation of all evil. Himself suffering from one of the most excruciating and hopeless of diseases, he seeks to fasten his venomous fangs in the flesh of every living creature, as if he took a malignant pleasure in inflicting his own agonies on all within his reach. Nor is this peculiarity confined to the rabid dog. All animals that naturally use their teeth as weapons of offense when attacked by the violent type of rabies are seized with a similar uncontrollable desire to bite; and as the saliva of the sick is alike virulent in all genera, the danger of the propagation of the malady in this way is very great. The losses from rabies among men and farm animals run far higher than is generally supposed, and are confined to no season, the popular prejudice against the *dog days* to the contrary notwithstanding. In seeking to reduce these or obviate them altogether much is to be done in the way of—first, regulating the keeping of dogs; second, in advice for the private management of dogs by their owners; third, in protection against the free importation of dogs from countries in which rabies abound; fourth, in acquainting the general public as to the early symptoms of rabies; fifth, in the destruction of all rabid dogs and of all exposed animals that naturally use their teeth as weapons of offense; and, sixth, in the supervision and frequent examination of exposed animals of genera that do not use the teeth, for a sufficient length of time to insure that no form of the disease, either of a violent or occult type, shall be developed. The destruction of the rabid animal may safely be left to people in the locality, but further precautions would demand the interference of a board of health; hence, all cases of rabies should be reported to it, that suitable protective measures may be taken.

MALIGNANT ANTHRAX IN ALL DOMESTIC ANIMALS, AND MALIGNANT PUSTULE AND INTESTINAL ANTHRAX (MYCOSIS) IN MAN.

In all the protean forms of malignant anthrax in animals, we find an infecting material which is not only deadly to quadrupeds, birds, and even reptiles and fishes, but which may be successfully inoculated from any one of these upon the human subject. The malady when conveyed to the human subject is a very deadly one, whether it shows itself on the surface in the form of malignant pustule (Siberian boil plague), or internally, as *carbuncular sore throat* or *intestinal anthrax.* In this country it prevails mostly among butchers, tanners, and workers in hair, but is also well known as the result of consuming the flesh of infected animals. Infection from simple contact is by no means uncommon. Quite recently I saw an outbreak in which one hundred cattle and three men suffered. In a second, twelve cattle and

two men. In a third, a cat conveyed the malady to a young lady who nursed it. Where the disease becomes widespread, the resulting human mortality may be excessive, as when, in 1770, fifteen thousand men died in six weeks in San Domingo from eating the diseased beef. Cooking is a very insufficient protection, as the resting spores have been shown to survive a boiling temperature, and, in particular cases, even 300° Fah., and a whole family were poisoned in Aberdeen, Scotland, by the beef that had been boiled for hours in broth. Further, and contrary to what holds with most other forms of virus, it is not essential that the skin should be broken in order to its absorption, and numerous instances can be adduced in which fatal results followed when it was deposited on the sound skin. Frost has no influence on its potency, and I have known a number of animals fatally infected by licking the frozen blood from a stoneboat, when the temperature was below zero. Nor is time nor putrefaction to be relied on. I have known cattle to perish promptly after lapping the liquids that leached from a grave in which an infected carcass had been buried nearly a year before. I have further known pastures, on which the disease had been developed for the first time in the memory of the inhabitants, maintain their infecting qualities for six years in succession, and to yield hay which continued to infect animals when fed to them at a distance from such pastures.

Being enthetic rather than infectious, this malady fortunately rarely attains to the dimensions of a plague, and rarely extends very widely from its true sources of origin. These are mostly in damp lands with a soil rich in decomposing organic matters, and especially such as have an impervious subsoil, or which, by reason of the basin-like conformation of the locality, have no sufficient drainage. Rich river bottoms and drying-up marshes, ponds, and lakes, lands that have been overmanured, and those supplied by drinking water collected from the surface or from strata rich in organic remains, are especially liable to be centers for the reception and preservation of this poison. In such localities, those animals are especially liable to contract the disease which are already in a somewhat morbid condition, excessively plethoric, having the blood charged with hurtful elements, the result of disease, faulty diet, or imperfect elimination, that have had secretions retained or fever developed in connection with hot dry seasons, lack of water, gastric and intestinal impactions, hot close buildings, insolation or excessive alternations of midday heat or midnight cold, and finally those in which from rapid growth or assimilation the tissues are soft, lax, and watery. With such animals, and in such localities, the disease is very likely to appear, and to continue to appear with increasing frequency and fatality, so that such places come to be known as "*dead lots*," and are avoided by all judicious stock owners. The malady is always confined to limited districts, unless where the above-named conditions extend over a wide territory, as in the rich alluvial steppes of Eastern Europe and Asia, in the plains of India, and in certain of our own rich river bottoms and prairies. It deserves to be stated that, like malarious fevers in man, this affection has become increasingly frequent throughout most of the United States in the past few years. While there is a strong probability that the disease is due to a microphyte—*Bacillus anthracis*—which is found in the blood in all the worst cases, and that certain conditions of the animal system are necessary to cause it to branch out into its special pathogenic development; yet, when its virulence has once been acquired it maintains this through an indefinite number of generations of the virus, and proves one of the most indestructible of known contagia.

Like glanders and rabies, therefore, this disease will demand a careful control by a National Board of Health, and measures must be resorted to for limiting its area and extirpating it wherever it threatens to attain to a dangerous prevalence.

TUBERCULOSIS IN ANIMALS AND MAN.

It is only since the inoculation experiments of Villemin, that the dangers resulting from tuberculous animals have been at all appreciated. To-day, after ten years of experimental observations by Villemin, Viscar, Klebs, Zurn, Bollinger, Leisering, Chauveau, Bagg, Semmer, Guenther, Harms, Biffi, Virgad, Gerlach, Buhl, Tilbury, Fox, Burden Sanderson, and a host of others, it has been definitely established: 1st, that tuberculosis can be transmitted from animal to animal, from man to animals, and, presumably, from animals to man by inoculation, or by the accidental contact of tuberculous matter with a raw or abraded surface; 2d, that raw tuberculous matter taken from man and animals and eaten by other animals may determine tuberculosis in the latter; 3d, that even the flesh of tuberculous animals will sometimes produce tuberculosis in animals that consume it, though with less certainty than if the tubercle itself were taken; 4th, that the milk of tuberculous animals will at times produce tuberculosis in susceptible objects, and above all where the morbid deposit has taken place in the udder; 5th, that cooking of the tuberculous matter gives no guarantee of protection, as flesh is a poor conductor of heat, and tubercle that had been boiled from a quarter to half an hour has readily infected a number of animals that partook of it; 6th, that tuberculous matter mixed with water and thrown into the air from an atomizer causes with great regularity the development of tubercles in the lungs of animals respiring such air. The above conclusions will admit of some qualifications. It may be admitted, for example, that the consumption of the flesh and milk of tuberculous animals is often followed by no perceptible injury. Phthisical cows are often eaten without causing obvious disease in the consumers. I have known large dairies of tuberculous cows, in the hands of vigorous and healthy-looking owners, who consumed the milk freely. I have kept two rabbits consuming all the milk of a tuberculous cow for months, and until the latter died, without developing any signs of tuberculosis in the rabbits. I have kept other rabbits for two months on the milk of a cow suffering from acute tuberculosis without any appreciable evil result. It may be freely concluded that a large number of individuals, while in the enjoyment of robust health, will withstand the influence of tubercle taken in by the stomach, but it must be otherwise with the weak and young, those with poor feeding and worse air, those living in damp, sunless localities, and subjected to much exposure. In a case that recently came under my notice in Brooklyn, N. Y., a family cow was found in an advanced state of tuberculosis, and the owner (William Martin) and his wife were evidently rapidly sinking under the same malady. In another case reported to me by Dr. Corlies, of New Jersey, a family cow, supposed to be suffering from the lung plague, was found to be afflicted with tuberculosis instead, and the owner's wife (a consumptive), who had been making free use of the milk warm from the cow, was persuaded to give it up, and underwent an immediate and decided improvement. It is for infants and adults who are somewhat infirm or out of health, or whose surroundings are not of the most salubrious kind, that the danger is greatest, but this embraces such an extended class that the moral interests involved are almost illimitable. The destruction of infancy and wasting of manhood from this cause are unquestionably far greater than has been heretofore realized; and on the moral ground alone this subject demands the watchful attention of a board of health. But even as a financial question, and as estimated by the losses of live stock alone, the subject attains to wide proportions. The infection of tubercle once introduced will often extend from the single diseased animal to a whole herd with startling rapidity. Last winter I visited a herd of sixty Devon cattle that were reported as perfectly sound six years ago. At that time a bull was bought which proved tuberculous, and the disease had steadily increased until at the time of my visit there was not a sound animal on the premises. Into a second herd nine poor calves were introduced in the fall of 1878. They were afflicted with a cough, which soon attacked the five other calves on the place, the eight cows, and two cows of a neighbor that pastured with them. At the time of my visit in the spring of 1879 all showed distinct symptoms of tuberculosis.

These may be thought to be extreme cases, but I am acquainted with districts in which thirty per cent. of the cattle suffer from tuberculosis, and, with many high-priced herds in which this scourge yearly claims its victims. In his experiments, Professor Gerlach had to utterly discard certain strains of high-bred swine, because of the astonishing frequency of tuberculosis in these subjects.

This disease opens up an extensive field for sanitary work, and particularly in the neighborhood of large cities, where so many infants, subjected to all the depressing influences of city life, are sustained by the milk of cows kept in unwholesome stables and fed so as to secure the greatest possible yield of milk, irrespective of results. Here the environment of the cows that yield the milk and that of the children who consume it are altogether favorable to the propagation of tubercle, and the subject requires the most careful supervision of the sanitary authorities.

The great mass of the adult city population is only a degree better in this respect than the infants; and as the cattle that are no longer useful for milk are too often made into beef, or rather sausages, the children of a larger growth are confronted with the risk of tuberculous meat as well as infected milk. The same dangers attend on the country districts, and though they are to some extent counteracted by pure air and better surroundings, yet the taint, if once introduced into a herd, tends to undergo a steady increase, until, as in the case of the country herds I have referred to above, all fall under its baleful influence. Then, again, in most of our large cities the cows are not kept over one season, but are constantly being replaced by fresh ones from the country; and it is only by purifying the source of the trade that we can secure sound cows in the cities.

That a supervision and restriction of tuberculosis is demanded cannot for a moment be gainsaid; but in view of the enormous proportions of such a work and the great monetary interests involved, together with the recent data of all exact observations on the transmissibility of the contagion and the different results obtained in different cases, it would be well, before proceeding far in this matter, to conduct a series of experiments which would tend to determine more accurately the conditions in which the different products are virulent and the circumstances in which exposed animals are susceptible. The proper supervision of this affection will demand the most careful consideration of the soundest and most enlightened minds. It would demand —first, the enforcement of a series of sanitary rules for the construction and management of city and suburban cow stables, embracing the sites, exposure, drainage, space per animal, ventilation, water supply, food, cleanliness, etc.; second, a professional inspection of the cow stables to insure that no cow with active tuberculosis is kept for the supply of milk, and no bull for the propagation of his kind; third, a professional inspection of the slaughter houses and poulterers, to see that no flesh nor other products from dangerously tuberculous animals are allowed to pass into consumption as human food. As far as possible a sanitary control should be established over country herds as well, and means should be taken to extirpate the disease and remove its causes in the many districts in which the affection has become domiciled as an enzootic.

MALIGNANT (ASIATIC) CHOLERA.

With the threatened approach of a new visitation of cholera, the National Board of Health must apply to the lower animals all those precautions which have proved beneficial in warding off this scourge from the human race. In this connection it need only be stated that Annesley, Jamieson, and many other Indian physicians testify that during cholera epidemics the domestic quadrupeds often showed a greater mortality than man, and that poultry yards were utterly depopulated by the scourge; that Hildebrandt, Hering, Dick, Reynal, and others record the ravages of this plague simultaneously in man and animals in Europe; and that Burden Sanderson and others have produced the disease experimentally in the rodents by feeding paper dipped in the virulent alvine discharges of men. It has often been noticed that birds disappeared during cholera epidemics, the rational explanation being that they perish. This will especially demand the careful seclusion of all animals in cholera districts; the destruction, if necessary, of wild animals; the disinfection of all bowel dejections and of the carcasses of animals dying of the plague, as well as of the places and loose objects where the sick have been; and, lastly, the most careful attention to prevent further infection through fodder, litter, or other solids, and through surface or underground drainage, natural or artificial, into wells or streams, into contact with the food of men or animals, or the places where animals resort to lick the soil. It is evident that no system of protection can be effective that fails to recognize that the lower animals transmit this virus as well as suffer its consequences.

MILK SICKNESS.—THE TREMBLES.

The great importance of this disease has failed to be recognized, mainly because its source is to be found in certain backwoods districts rarely penetrated by those who preside over our medical literature, and because it gradually recedes before the advance of improved agriculture. Many medical men indeed express grave doubts as to its very existence. Yet the history of the malady is so circumstantial and clear that a doubt as to its specific nature is eminently disingenuous. In its source in unimproved marshy localities it closely resembles the malignant anthrax, also in its communicability to all animals, but it differs essentially in that it fails to show local anthrax lesions, in place of which it expends its energy on the nerve centers, producing great hebetude and loss of muscular power. According to Dr. Phillips, it is characterized by the presence in the blood of a microzym (spirillum), like that seen in relapsing fever. The germ is probably derived from the drinking water or the surfaces of vegetables, as certain wells are found to infect with certainty, and the disease has been repeatedly produced by feeding upon particular plants (*Rhus toxicodendron*, etc.). That these plants in themselves are not the pathogenic elements, is shown by their innocuous properties when grown in places out of the region of the milk-sickness infection. It seems altogether probable that here, as in malignant anthrax, we are dealing with a microzym which has developed pathogenic properties and which can be reproduced indefinitely in the bodies of living animals. The great danger of this affection consists in the conveyance of the germ with unimpaired potency through the flesh and milk and through the manufactured products of the latter—butter and cheese. Some even hold that in animals giving milk the system does not suffer materially, but that it is saved by the drainage of the germs through the mammary glands, and that thus a milk-sick cow may remain for a considerable time unsuspected, while her milk, butter, and cheese are conveying mental and physical decay and death to many human beings, near and remote. For the disorder proves as fatal in man as in animals, and if in particular cases it fails to destroy life, it usually leaves the subject in a condition of hebetude and physical weakness that make life miserable.

The permanence of the germ in butter and cheese renders inevitable the conclusion of physicians in milk-sick districts, that cases of this disease must be frequent in city populations, but that its true nature is not recognized by the medical attendants. The whole subject demands a thorough experimental investigation at the hands of the National Board of Health, so that the true source and germ of the malady may be discovered, if possible, and that in any case intelligent measures may be taken to prevent its conveyance out of its native habitat.

SMALL POX IN BIRDS.

In Europe and Hindostan variola is so common in pigeons and poultry as to constitute a veritable plague. Thus Guersent records that out of a dovecote of one thousand scarce one hundred could be found that did not bear marks of the disease, while Tytler says the poultry yards in India were habitually depopulated by the plague. Bechstein and others claim that this is the true small-pox derived from the human being and conveyable back to man, while others, like Toggia and Gilbert, assert that it is communicable to the sheep. That this affection has not been recognized among us may be due to a difference in the environment which modifies the infection, or, perhaps, to the fact that men and pigeons do not live so much in common here in Italy and India. Such an occurrence under Italian skies should, however, demand a careful investigation into the reality of such infection in our own States, and especially the Southern ones, during the prevalence of an epidemic of small-pox, so that whatever danger arises from this source may be detected and guarded against.

ECZEMATOUS (APHTHOUS) FEVER IN ANIMALS.

Although this disease is communicable to man in a mild form, and to infants who live on the fresh milk in the form of a violent and even fatal inflammation, yet, as it has at present no foothold on this continent, and, like rinderpest, sheep-pox, dourine, quebra bunda, etc., may be easily excluded by inspection and quarantine at our ports, it will be best to leave it with the purely animal plagues to the control of a veterinary sanitary bureau, and thus avoid the multiplying of inspectors.

TYPHOID FEVER IN SUCKING CALVES.

Reports have lately been published of the occurrence of this disease in calves, and of the infection of a number of persons that have eaten of the veal; it seems very desirable, therefore, that experiments should be instituted to ascertain whether animals kept on an exclusively milk diet are susceptible to this infection of man. It seems altogether probable that a mistake has been made, and that the calves and their victims died of trichiniasis, intestinal anthrax, or of some other poison common to man and animals: but it should at least be shown by the National Health Board that the danger of the alleged transmission of typhoid fever is altogether fanciful.

TRICHINIASIS

The life history of the trichina spiralis is now fully understood. The parasite is harbored by very many mammalia, and, probably, even by reptiles, but is, above all, common in rats, pigs, and men. It has its two principal stages of existence—the *sexually mature* form, which lives and propagates its kind in the intestines only, and the *immature asexual* form, which, born in the intestines, bores its way through their walls and into the voluntary muscles, where it encysts itself. These last attain maturity only when their host is devoured by a carnivorous animal, and when the cyst is digested off so as to set the imprisoned trichina free. A third habitat may be named for those embryos that have been carried out of the system by the prevailing diarrhea ere they have had time to penetrate the intestinal walls and seek an asylum in the solid tissues. These can live for an indefinite length of time in pools of water without undergoing further development, until they are taken in by a mammalian host, when they penetrate the intestinal walls and encyst themselves in the muscles.

All this has been known for many years, but sanitation has advanced no further than to advance the microscopical examination of all pork, to enjoin that it be thoroughly smoked or well cooked before it is eaten, and to utter a warning against keeping pigs about slaughter houses and feeding them on the raw waste products. Meanwhile, our pork hams have been, rightly or wrongly, acquiring a most undesirable reputation. Dr. Belfield and Mr. Atwood, of Chicago, pronounce eight per cent. of the hogs killed in that city to be trichinous, and several European countries have forbidden the importation of American hams. In Germany, on the other hand, where all pork is subjected to microscopic examination, the statistics show that trichina have been found in but one of two thousand hogs examined.

The protection of our population against this tremendous scourge, and of our market against the embargoes of frightened Europeans, demands a system which shall reach further and prove more thorough. The feeding of pigs on any flesh that is not thoroughly cooked should be strictly prohibited, a trichina inspector should be made to examine all pork exposed for sale, in our cities especially, and any discovery of trichinous pork, whether from such inspections or from the occurrence of the disease in man, should lead to such inquiries as would in all possible cases dis-

cover the source of such pork, and then should follow the destruction and prolonged boiling of all hogs, dogs, cats, rats, mice, snakes, and other carnivorous animals on the premises, the burning of the hogpens and manure, and the closure of the yards against hogs for one year; also the shutting up of all wells or other collections of water to which the swine may have had access or into which drainage from the pens could have taken place.

Further, examination should be made in such localities of all animals, vertebrate and invertebrate, that the hogs could be expected to have devoured. Under such a system not only may we hope for a material decrease of trichinous hams and bacon, but for valuable discoveries of hitherto unsuspected and dangerous hosts of parasites, so that the work of extermination would continually become more easy and effectual.

ECHINOCOCCUS.

In all countries where it abounds (Iceland) this is one of the most destructive of the parasites of man. In the United States it is by no means so common as to give rise to much apprehension, and yet an examination of the internal organs of animals slaughtered, and a consultation of medical records, show that it is far from uncommon. As the parasite is derived from the dog, and as its tænia form in the bowels of that animal is so small as to be rarely recognized, it is likely to cause great damage before its presence is suspected in a locality. This is but one of a myriad of heavy charges that must be brought against the crowds of useless curs that everywhere abound and more or less directly impair the health and prosperity of the people. With man alone the dog reciprocates in sustaining no less than seven dangerous animal parasites, in addition to the vegetable ones, producing the different forms of ringworm; with cattle and sheep he joins in maintaining three that devastate our herds and flocks. His ubiquity is a continual threat of canine madness to all living things. He has remanded to nature, or to less productive culture, large tracts that are admirably adapted to the raising of sheep, but where the losses from the devouring jaws of the dog have rendered sheep farming unprofitable. Sanitary considerations alike affecting man and beast, therefore, demand a rigid control of dogs and the imposition of a tax that shall be to a large extent prohibitory of their maintenance. Further, whenever *Echinococcus, Cysticercus tenuicollis, Bothriocephalus latus, B. cordatus, Strongylus gigas, Pentastoma tænioides*, or *Demodex folliculorum*, occurs in man, attention should be given to the condition of the dogs in the locality, and measures taken to prevent the propagation of these parasites through their systems.

OTHER PARASITES.

To go over the other parasites which are common to man and animals would serve no good purpose. They rarely attain to the gravity of an epidemic, and will only demand sanitary interference in very exceptional circumstances; yet the Board of Health must be so constituted that it can effectually deal with any of these in such an emergency. For this a veterinary sanitary committee will be always prepared, and will act mainly as an advisory body; but also, when necessary, in an executive capacity. Thus, an influx of measly pork should demand that it be traced to its source, and that its source, the tapeworm of man (*T. solium*) should be destroyed, while all pigs should be forbidden the infected ground for over a year. An influx of measly veal should demand a similar correction, and thus dangers of a material increase of either of these parasites will be done away with. In fishing localities where the *Bothriocephalus latus* or *B. cordatus* gains a wide diffusion it may become necessary to keep all dogs under the closest surveillance and to periodically rid them of the parasite. It might further become needful to control the consumption of certain fish or of fish-eating mammals likely to be devoured by dogs. The prevalence of *Sarcoptis mutans* (scabies) in chickens may become so great that it will entail a most inveterate itch in man, the true source of which is seldom discovered. Again, gregarina have lately been found in the lungs of chickens and in the bowels of pigs, and it seems quite within the bounds of probability that as they live on the hairs of man, so they may at times infest his internal organs.

For the above reasons it is desirable that Congress should provide for the incorporation with the National Board of Health of one or more veterinarians, whose functions it would be to consult with the present members in all matters in which the health of the lower animals affects that of man; to advise as to the enactment and administration of State laws for the prevention and extinction of plagues and parasites common to man and animals; to conduct experimental researches into the source, propagation, and extinction of these disorders and parasites of animals, and to act when necessary in an executive capacity in the exclusion or control of these scourges. To carry out these objects Congress should be asked to appropriate a sum of money, to be expended, as may be seen to be best, in experiments, in investigations, and in the control of these epidemics and epizootics.

Plagues and parasites peculiar to the lower animals.

In turning now to the communicable disorders of the lower animals to which man shows no susceptibility, we face a much more extended class. No less than thirteen different forms of contagia and thirty-four different parasites exist, any of which may induce a prevalence that rises to the dignity of a plague. Among the contagia given in our list the majority are probably indigenous to our soil, while four are certainly exotic. Of the latter but one (lung plague of cattle) is known to exist at present in the United States, but that one more imperatively demands instant and effective action than all our plagues of home birth. Arising in this country from contagion only, and having an excessive incubation period (one to three months), it can be spread with the greatest facility by animals that carry the seeds of the malady, but have not yet developed the disease. Having a constant tendency to the death of tissue and to the encystment of this as a mass (infecting material), which remains unchanged for many months in the chests of animals that are thought to have recovered, it is ever liable to be spread by the apparently convalescent. Add to this that this contagion, if once carried to our Western and Southern rock ranges, could never be eradicated, but must remain as a permanent incubus and scourge as it has on the Steppes of Russia, the open lands of Australia, and the unfenced ranges of Southern Africa, and we see reason why a prompt attention should be given to its speedy extermination. If more is wanted to enforce this, it is the calculation (based on the European losses from this plague and the steady increase of our own herds of cattle) that this pestilence, left to itself and extended to our Western stock ranges, will probably lay us under a tax of $130,000,000 per annum. But the flesh of animals attacked with this plague has never been shown to be injurious to man, and thus the question of its extinction is an exclusively pecuniary one and demands the action of the stock owner rather than the sanitarian. While the necessary steps to insure the extinction of this and allied plagues are sufficiently well known to the veterinary profession, and while effectiveness and promptitude are best secured by placing the matter in the hands of one executive head, yet it will better command the confidence of the stock owners and indirectly of Congress if one or two representative stockmen are officially connected with the work.

While on purely professional matters the veterinarian must, of course, decide, and in the execution of the work which is essentially professional he should direct, yet in many subjects connected with cattle raising and the peculiarities of the trade in different parts of the country the knowledge and experience of the stockman will be of inestimable advantage in arriving at safe and effective local enactments that will not unnecessarily harass or hamper trade on the one hand nor be easily evaded on the other. A small committee or bureau of this kind, clothed with executive authority and with financial means equivalent to the end, could make much more effective work than could a committee of the Board of Health, who could not be got together to meet every emergency. Again, the first part of this sanitary work must be done as speedily as possible, because of the great and increasing dangers that attend upon delay, and to secure this it will be necessary to appropriate a large sum of money to enable the executive to carry it on with uninterrupted energy to the end, since any suspension for lack of funds would entail the renewed spread of the disease and the loss of all that had been already expended. This consideration is a vital one, and of itself would decide me in favor of a separate executive, for the exclusively animal plagues, to be furnished with abundant means and full administrative power. A supplementary appropriation to the Board of Health, which might be largely used up for what at the moment and as viewed from a moral standpoint might appear as a more urgent demand, would be hurtful to both human and veterinary sanitation. If, for example, the work of exterminating the cattle lung plague had to be entirely arrested for want of means, it would soon again extend over the ground which it had lost, all that had been expended on it would be forfeited, and there would be much less likelihood of a speedy resumption of the work. If even the work were only retarded for lack of means, as has been the case in New York for the past three months, if the executive could only quarantine infected herds and partially control the movement of cattle, but could not kill the sick for want of means to indemnify the owners for their losses, a most hurtful blow would be dealt to the entire system of national sanitary legislation and administration. In either case the most prominent fact before Congress and the people would be that so many hundred thousand dollars had been expended for the extinction of a plague which, when the next appropriation was requested, either prevailed as widely as at first or was only appreciably less prevalent. All representations that the want of success had been due to the lack of means would receive little attention; the community would conclude it better to squander no more money on the matter; all further veterinary sanitary legislation would probably be rendered hopeless; no small amount of opprobrium would be thrown on the National Board of Health itself, and a severe blow would be dealt to all national health legislation.

It is especially fortunate that, by reason of the active measures carried out in the first six months of our work in New York, we can now point to seven counties virtually cleared of the pestilence, and by later restricting our work to controlling movement of cattle, we have been able to prevent any renewed extension of the pest; yet with a little more means New York might have been to-day all but clear of this scourge.

The time may come when the nation will be sufficiently educated to allow the sanitation of man and animals to be controlled by a single National Health Board; but at present, and for the exclusively animal plagues, we cannot afford to run any risks, and that method should be followed which will secure a certain and speedy result, and establish the principle of the extinction of such pestilences on a sound and unassailable basis. I would therefore urge as the result of mature deliberation, in view of all aspects of the question, that the control of those animal contagia and parasites which affect man as well should be placed in the hands of a veterinary committee of the National Board of Health organized for this purpose, while the exclusively animal plagues and the parasites that affect animals only should be committed to an organization drawn from the stock owners and the veterinary profession, and not too large or unwieldy for the most prompt and effective action.

I consider it needless to encumber this statement by any further reference to the other animal plagues and parasites, as I would not recommend *immediate* executive action for more than one other in addition to the bovine lung-plague. Besides this, the work of the special veterinary organization would consist mainly in controlling the imports of live stock and advising as to the management of local epizootics which did not immediately threaten the nation at large.—*National Board of Health Bulletin.*

STATISTICS OF TWO HUNDRED AND FIFTY CASES OF CANCER OF THE BREAST.

Dr. Oldekop publishes an extended report of 250 cases of carcinoma of the mamma, which were treated in Prof. Esmarch's wards in Kiel between the years 1850 and 1878. Of these cases, 21 were not operated on. Of the remaining 229, 23 died in consequence of the operation; in 109 the tumors returned; in 43 the tumors did not recur, some of these patients being still alive, while others have died of intercurrent diseases; in 54 the patients were lost sight of after they left the hospital. The majority of the patients were between 46 and 50 years of age; the average age at which the disease first made its appearance was 48·4 years. Of the patients, 208 were married, and 30 single. Of 103 who had borne children, 36 had suffered from puerperal mastitis. In 9 cases the tumor developed from nodules left by previous mastitis. The statements with regard to previous injury were uncertain. The cancer affected the right breast in 123 cases, and the left in 102. The upper and outer half of the gland was most frequently affected. In 11 cases hereditary predisposition existed, and in 60 cases it could be positively excluded. In 31 cases in which the axillary glands were not involved, the average duration of life after the operation was 45·1 months; period of freedom from relapse 6 months. In 57 cases in which the glands were involved, the average duration of life after the operation was 34·8 months; period of freedom from relapse 2·5 months. The average duration of life from the first appearance of the disease was, in the cases not operated on, 22·6 months, and in the cases operated on, 38·1 months. On 225 patients, 287 operations were performed, with 23 deaths. Out of 184 operations performed before the introduction of Lister's method, there were 16 deaths, a mortality of 8·7 per cent.; out of 77 performed under antiseptic precautions, there were 7 deaths, a mortality of 9·1 per cent. The average period of convalescence was formerly 5·2 weeks, but after the adoption of Lister's method it fell to 4·6 weeks. In 40·9 per cent. of the patients the entire mamma with the glands was removed (mortality 13 per cent.). Of the 23 deaths from the operation, 12 were due to accidental surgical diseases, 4 to collapse and secondary hemorrhage, 1 to pneumonia, and 6 to causes that could not be clearly ascertained. Erysipelas occurred 15 times, and proved fatal in 5 cases. In 46·4 per cent. of the cases the recurrent tumors appeared within the first three months after the operation; after that period the recurrences diminished steadily in frequency, and after one year they only occurred in 18 cases, or 16 per cent. A reappearance of the tumor after three years' interval was only observed in one case, and in that there was some room for doubt. Hence three years may be regarded as the limit for the appearance of recurrent tumors. If this be accepted as correct, 23 of Esmarch's cases may be regarded as definitely cured. The seat of recurrence was far more frequently the cicatrix than the axilla; and when the operation was limited to the removal of axillary glands, the recurrent tumors generally appeared in the axilla. Dr. Oldekop concludes his paper with brief synopses of the histories of the 250 cases.—*Langenbeck's Archiv.*

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